Computerized Speech Lab (CSL™) and Multi-Speech™

Operating Manual

Instructions for Use

Models 4500b and 3700

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1 Introduction

The CSL™ Main Program (CSL) is a hardware and software system for the acquisition, acoustic analysis, display, and playback of any acoustic signals characterized by changing spectra over time, including speech signals. It is used for the recording and display of acoustic parameters of speech and voice signals for linguistic, forensic, and communication sciences applications

Multi-Speech™ is a software only version of CSL. It is a comprehensive speech recording, analysis, feedback, and measurement program which uses standard multimedia hardware to capture acoustic signals and includes the same analysis features as CSL software. Multi-Speech software options include; Auditory Feedback Tools, Voice Games, Motor Speech Profile, Real-Time Pitch, Real-Time Spectrogram, Sona-Match, Multi-Dimensional Voice Program, Analysis of Dysphonia in Speech and Voice and iCAPE-V.

The CSL is compatible with the same optional modules of Multi-Speech, as well as Voice Range Profile, and Real-Time EGG

CSL and Multi-Speech:

- Capture multiple channels of acoustic signals (up to four channels simultaneously) at a wide range of sampling rates. (Note: typical application is to use only one channel at a time.)
- Provides tools for management and editing of speech/voice samples for analysis.
- Performs spectrogram, FFT, and LPC analysis and displays formants, pitch contours and energy contour.

1-1 Intended Use

The Computerized Speech Lab, CSL, Model 4500b, is designed for the acoustic analysis of signals in a wide variety of applications including assessment of disordered voice & speech and linguistic analysis, and forensic acoustic applications. The typical operating environment is in a lab, office, sound booth, medical examination room, or speech therapy treatment room. The CSL, Model 4500b system is suitable for use in a patient environment.

1-2 Indications/Contraindication for Use

The CSL is a professional-level product designed for the office, lab, or clinic for assessment and therapy of voice and speech. This product is not designed for O.R. use.

1-3 Undesirable Effects

The use of headphones for listening has the potential side effect of damage to the client's hearing. Consult the manufacturer's instructions for safe use.

1-4 User Requirements

Users should be thoroughly trained in the procedures appropriate to the equipment.

1-5 Hardware Considerations

For information about hardware specifications, installation, and operation, refer to the *Computerized Speech Lab (CSL*™) *Hardware and Installation Manual*..

1-6 Warnings and Precautions

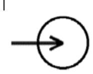
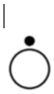
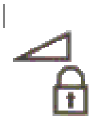
> **Warning**
> You should read and understand the instructions in this manual before you perform any procedures using CSL and Multi-Speech. Failure to do so may result in injury to the patient or damage to the instrument.

Warning and Caution messages appear throughout this manual in the following formats:

> **Warning**
> Warning messages tell you about conditions that could result in death or serious injury.

> **Caution**
> Caution messages tell you about problems that might result in minor or moderate injury, or property-damage.

1-7 Symbols Used

Symbol	Indicates	Symbol	Indicates
	Instruction manual symbol. The product is marked with this symbol when it is necessary for the user to refer to the instruction manual.		Input
	Type B Applied Part		Output
	Type BF Applied Part		Dangerous Voltage
	Alternating Current		“Off” (Only for a Part of Equipment)
	Direct Current		“On” (Only for a Part of Equipment)
	Protective Earth (Ground) Terminal		VRP Mode

1-8 Risks of Reciprocal Interference

This equipment is intended for use in a clinical environment by healthcare professionals only. It provides reasonable protection against harmful interference in a typical clinical installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment causes or receives detectable interference, you can limit it by using one or more of the following measures:

- Reorient or relocate the affected device.
- Increase the separation between devices.
- Connect the equipment into a mains outlet on a different circuit from the device(s) causing the interference.
- Consult the manufacturer or field technician for help.

During playback, amplitude levels are restricted to levels below that which would damage human ears. Typical precautions for audio playback should be observed when using additional peripherals such as headphones.

1-9 Maintenance and Calibration

There are no maintenance or calibration procedures for the CSL and Multi-Speech hardware. Although the microphone does not wear out, it can be damaged. Consult the instructions provided with the microphone for repair or replacement information.

1-10 Non-Medical Equipment

CSL meets the medical standard for UL60601-1 and EN60601-1

When the unit is installed in conjunction with other equipment to operate as a medical electrical system, that system is to be tested at the end-user facility after installation to guarantee compliance with the system leakage current requirements of IEC 60601-1-including the required use of a medically approved (60601-1) safety isolation transformer.

1-11 Using this Manual

You should read and understand the instructions in this manual. The manual uses the following conventions:

Convention	Definition
Note	Important information about a subject or the use of the device. Failure to follow a note can result in configuration or installation issues.
Bold lettering	Menu option or button, or text you should select or enter.
Italics	Reference to other sections in this manual or to other documents.
1. Text	Procedure with more than one step.
➢	Procedure with one step.
Start → Shutdown	Path that shows menu selections in sequence.

Note You can use this manual in its print form or click [?] in the application title bar to view a version in .pdf format.

1-12 Contacting PENTAX Medical

If you have operational questions or cannot solve a problem by using this manual, contact your local representative; if you are in the United States, contact PENTAX Medical directly (toll free at 800-431-5880 or e-mail customerservice@pentaxmedical.com).

1-12-1 Reproduction Policy

Data contained in this manual is copyrighted by PENTAX of America Inc., and is furnished solely for the purpose of providing instructions for operation and maintenance of the apparatus described herein. Said data shall not be used by the purchaser or the government for promotional procurement, development, or manufacturing purposes, nor shall the data be reproduced or disclosed without permission from PENTAX of America. In event of resale of the apparatus to the government, by the purchaser, the purchaser shall notify the government of the limited right to use said data.

1-12-2 Warranty

For information on additional warranty coverage, please contact your local representative.

2 System Components and Operating Requirements

CSL Main Program and Multi-Speech are designed to work with a variety of speech and auditory recording tools.

Warning
Do not connect the system to a wall outlet using an extension cord or an external multiple Socket Outlet. Use only an approved medical grade power cord.

Warning
To avoid risk of electric shock, connect this equipment only to a supply mains with protective earth.

Warning
This equipment is not suitable for use in the presence of a flammable anesthetic mixture with air, oxygen, or nitrous oxide.

Warning
To reduce the risk of fire and electric shock, do not expose electrical equipment to moisture and dust.

Caution
This product has no serviceable parts. Do not disassemble the unit.

Caution
Do not modify this equipment without authorization of the manufacturer.

Caution
Accessories connected to the USB port must be certified to *IEC 60950-1 Information Technology Equipment–Safety–Part 1: General Requirements* for data processing equipment, and *IEC 60601-1 Medical Electrical Equipment–Part 1: General Requirements for Safety* for medical equipment.

2-1 System Components

Note All PCs used for this product must meet the following specifications and be used with a suitable (60601-1 qualified) isolation transformer, Medical grade (60601-1) Power supply or Medical Grade (60601-1 qualified) PC.

Note Addition of new hardware or software to the system can have unintended consequences. Consult the manufacturer before installing new hardware or software to determine compatibility.

Note System components may be upgraded without notice.

CSL Model 4500b includes the following parts:

Figure 1. CSL Model 4500 parts

Unpack and inspect the CSL. The following parts should be included:

- CSL external module with power cord
- Lynx E44 audio card
- DB-25 cable to connect CSL external module to E44 audio card
- Cables (3): Audio card interface to male XLR and female XLR, male XLR to RCA, and female XLR to RCA.
- Security key
- Speaker with cable
- Shure dynamic hand-held microphone and XLR cable
- Headphones
- Two RCA female to ¼" phono male adaptors
- *Computerized Speech Lab (CSL) Hardware and Installation Manual*
- Software installation disc with the CSL software, required device drivers, and a PDF of the software operating manual
- *Speech Products Software Installation Instructions*

Note If for any reason parts are damaged or missing, immediately contact the factory or a PENTAX Medical representative.

2-2 System Requirements

Note All PCs used for this product must meet the following specifications and be used with a suitable (60601-1 qualified) isolation transformer, Medical grade (60601-1) Power supply or Medical Grade (60601-1 qualified) PC.

Note Addition of new hardware or software to the system can have unintended consequences. Consult the manufacturer before installing new hardware or software to determine compatibility.

Note System components may be upgraded without notice.

2-2-1 Desktop Computer Minimum Requirements

The computer used with CSL must meet or exceed the following specifications:

- Full size AT style PC case (tower or desktop)
- Intel® Core™ i5 processor or better
- 4 Gb system RAM
- 250Gb HDD or larger
- DVD ROM/RAM drive
- 1 free full height PCIe expansion slot
- 1 free USB 1.0 (or better) port
- VGA, HDMI or DP graphics card and monitor that supports a minimum screen resolution of 1280x1024 (4:3) or 1440x900 (16x9)
- Certified to EN60950-1 and/or UL60950-1

2-2-2 Laptop Computer Minimum Requirements for Multi-Speech

The laptop computer used with Multi-Speech must meet or exceed the following specifications:

- PC type laptop running Windows 10
- Intel® Core™ i5 processor or better
- 4 Gb System RAM
- 250Gb HDD or larger
- Stereo sound card with discrete 3.5mm microphone input (or adaptor)
- VGA, HDMI or DP graphics card and monitor that supports a minimum screen resolution of 1280x1024 (4:3) or 1440x900 (16x9).
- 1 free USB 1.0 (or better) ports
- DVD ROM/RAM internal or USB external
- Certified to EN60950-1 and/or UL60950-1

2-2-3 Isolation Transformer Requirements;

- Medical grade PCs or used with a suitably rated Isolation Transformer
- Certified to UL/EN/ISO60601-1 with leakage no greater than 100uA.
- Capacity (VA rating) to be higher than the steady state maximum load of both PC and Monitor connected, Ideally double.

2-3 Audio Quality

Multi-Speech operates as a stand-alone program, using PC audio cards for input and output, while CSL uses a professional-grade external sound acquisition module. Multi-Speech offers a low cost product with an inexpensive audio card, but at lower performance levels than CSL's professional system.

The limitations of onboard audio input stem from the high level of noise from the fans and drives operating inside a computer. A typical 16 bit audio card has an input SNR (signal-to-noise ratio) of about 40–60dB. Therefore, with a 16-bit sampling resolution, about half of the dynamic range is lost in noise. CSL with the external module has a SNR greater than 80dB. Marketing claims are often based on playback of motion pictures and other professionally recorded sound, and with many low cost cards, the actual SNR from captured audio is higher than the marketing specifications can indicate.

The CSL external module uses professional sound reduction techniques to achieve very low noise levels. A high quality microphone and external preamplifier can improve sound quality with Multi-Speech.

2-4 EMC Influences

The hardware used with CSL and Multi-Speech is intended to be used in an electromagnetic environment in which radiated disturbances are controlled. Portable and mobile RF communication equipment can affect medical electronic equipment. Care should be exercised in using medical devices near potential sources of RF emissions

2-5 Leakage Current

The power supply for the PENTAX Medical CSL, Model 4500b, was tested and shown to be in compliance with the leakage requirement of IEC60601-1.

2-6 Environmental Conditions

CSL and Multi-Speech require the following environmental conditions:

Operating Conditions:

- Temperature +10 °C to +40 °C
- Relative Humidity 20% to 80% (non-condensing)
- Atmospheric Pressure 700mb to 1060mb

Storage/Transportation Conditions

- Temperature –10 °C to +60 °C
- Relative Humidity 20% to 80% (non-condensing)
- Atmosphere Pressure 700mb to 1060mb

This product is a medical device. In accordance with European Directive 2002/96/EC on Waste Electrical and Electronic Equipment, this symbol indicates that the product must not be disposed of as unsorted waste, but should be collected separately. Contact your local PENTAX Medical distributor for correct disposal and recycling. By disposing of this product correctly you will help ensure that the waste undergoes the necessary treatment, recovery and recycling and thus prevent potential negative effects on the environment and human health which could otherwise arise due to inappropriate waste handling.

Note Follow local, state, and federal guidelines for the proper disposal of waste products.

2-7 Cleaning and Disinfecting

Warning

Appropriate personal protective equipment (gloves, fluid impermeable gown, face shield, and respiratory protection) must be worn during cleaning and disinfecting procedures.

Follow these guidelines for cleaning and disinfection:

- The keyboard, mouse, and microphone are non-invasive: they do not come into direct contact with the mucus membranes of the patient's mouth or nose. You can clean and disinfect them between patient procedures, using commercially available detergents and surface disinfectants.
- All microphones, digital recorders, and other equipment used for recording audio or other breath analysis must be properly sanitized according to instructions provided by the manufacturer for cleaning and disinfection.

3 Installation and Loading

The CSL Main Program and Multi-Speech are often used with an assortment of recording equipment. Read all instructions and cautions included with CSL hardware components, all recording equipment manufactured by PENTAX Medical or another supplier, and all software module instructions and cautions before use. The CSL Main Program and Multi-Speech are often one analysis module connected to a larger hardware and software configurations and additional safety and environmental conditions apply to each specific component.

3-1 Launching CSL and Multi-Speech

To launch CSL and Multi-Speech, turn on components in the sequence indicated below, skipping any that do not apply to your configuration.

1. Monitor
1. Host Computer
2. CSL External Module (CSL users only)
3. Preamplifier (if used with Multi-Speech)
4. External speakers

3-2 Connecting the Security Key

You need to install the security key in order to use the program:

Note Do not plug the security key into the computer until the application software and security key driver are installed.

➢ Plug the security key into an available USB port on the host computer.

3-3 Launching the Application

To start the CSL Main Program or Multi-Speech software:

1. At the desktop, select the CSL icon or the Multi-Speech icon.

   You can also open the launch bar from the Windows Start menu.

Figure 2. Multi-Speech Launch Bar

The launcher on your display can vary, and will include the CSL Main Program or Multi-Speech and other installed PENTAX Medical speech software.

4 Using CSL and Multi-Speech

This section introduces you to the core functionality of the CSL Main Program and Multi-Speech, its windows and toolbars, data markers, audio capture, playback, and other basic functions.

4-1 Windows and Toolbar

When you begin the program, your screen should look similar to the following display. Below the title bar and toolbar is the grey work area, where all open and minimized windows reside. The application defaults to two open windows but supports up to eight.

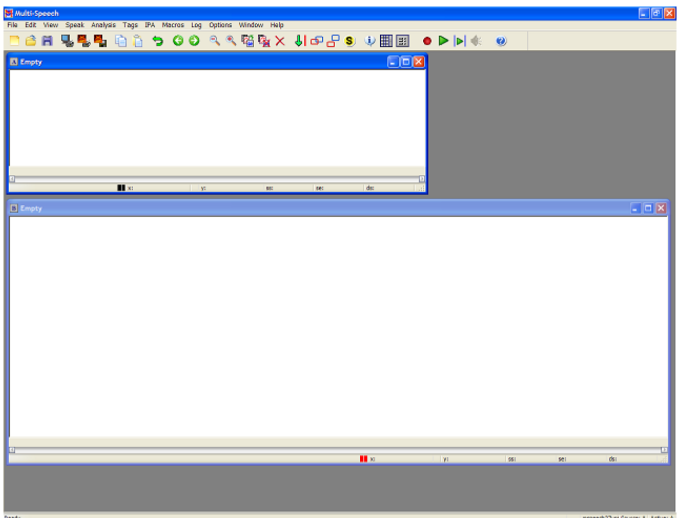


Figure 3. Application window on start-up.

Initially, there are two windows open: Window A is the active window, and Window B is an inactive window. Inactive windows can serve as the source window.

4-1-1 Quick Access Toolbar

The toolbar icons located directly below the upper dropdown menus provide shortcuts to some of the most commonly used features of CSL and Multi-Speech.

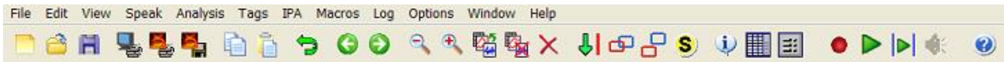
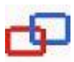
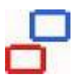
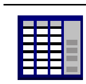
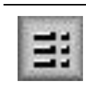


Figure 4. Quick Access Toolbar.

Button	Description
	New Window: Opens a new window with the dimensions of the current active window. The new window opened becomes the Active.
	Open Signal File: Load a file from disc. If the active window the file is being opened into contains data, that data will be purged (deleted).
	**Save Signal**: Calls a dialog box which allows you to save the waveform signal in the active window to a file.
	**Print Full Screen Image**: Calls a dialog box which allows you to send a graphic image of the screen to a printer. From the dialog box, optionally add a header and/or footer to the printed page, set the header/footer font, and select a printer.
	**Print Active Window Image**: Calls a dialog box which allows you to send a high-resolution graphic image of the active window to a printer.
	**Save Active Window Image**: Calls a dialog box which allows you to save a high-resolution graphic image of the active window in bitmap, JPEG, GIF, or PNG file format. From the dialog box, optionally adjust the image size.
	**Copy Signal**: Copies signal data in the active window to the clipboard.
	**Paste Signal**: Clears the active window, and then loads the signal data previously saved to the clipboard.
	**Undo Last Edit in Active**: Undoes the last edit made to the signal data in the active window.
	**Activate Previous Window**: Causes the previous window in alphabetical order to be active. Windows are labeled A to Z.
	**Activate Next Window**: Causes the next window in alphabetical order to be active. Windows are labeled A to Z.
	**View All Data**: Displays all graphic data associated with the active window.
	**View Selected Data**: Displays graphic data in the selected region of the active window.

Button	Description
	**Cycle Analysis Plots**: If the active window contains multiple analysis results, the top plot is put to the back of the analysis results list and the previous plot is brought to the front. Thus you can cycle through the analysis plots in a window. Spectrograms cannot be brought forward and should be plotted in a new window if needed.
	**Remove Top Plot**: If the active window contains multiple analysis results, the top plot is deleted and the previous plot is brought to the front.
	**Purge Active Window**: Clears the contents of the active window and removes any associated data.
	**Mark at Cursor**: Moves the green **data mark** in the active window (and any linked windows) to the current cursor location. When the data mark is moved, the x-axis box reports the current cursor location relative to the location of the data mark. This is indicated by an **R** beside the numerical value.
	**Link Window**: Links the active window to the default source window. Cursor movement, data mark movement, selection area definition and show operations are duplicated in linked windows.
	**Unlink Window**: Unlinks the active window from any other windows it was previously linked to.
	**Active > Source**: Makes the active window the source window.
	**Info**: Displays an information box on the contents of the active window.
	**Numerical Results**: Computes and displays numerical results for the topmost analysis data in the active window.
	**Statistics**: Computes and displays result statistics for the topmost analysis data in the active window.
	**Record Signal**: Starts the data capture routine.
	**Speak All**: Generates audio output of all signal data associated with the active window.
	**Speak Selected**: Generates audio output of the selected signal data associated with the active window.
	**Speak from Mouse Mode**: Speech playback begins at the location of the mouse click on the screen. Press and hold down **Left** mouse button to speak. Speech playback ceases when you release the mouse button, or when the end of the speech sample is reached.
	**Help**: Starts Help.

4-1-1 **Windows Scrollbar**

A scroll bar is displayed under the horizontal axis of some windows.

Note The window scroll bar may be displayed or hidden using the **Display Scrollbar** option in the Window Attributes box.

When all data are shown in the window, the thumb fills the scroll bar. When a portion of the data are shown, the thumb in the scroll bar shows the relative location of the currently displayed data.

4-1-2 **Cursors**

There are three types of cursors: the red data cursor, the green data mark, and the two blue selection cursors. You can use these cursors are used to mark and select data.

Data Cursor

The Data cursor: is a red vertical line that identifies a specific location. Initially, the data cursor is at the beginning of the data display.

To move the data cursor, you can:

- Left click the desired point in a window.
- Left click and hold the left mouse button in the current data cursor position and drag the cursor.

  The x-axis records the position of the data cursor relative to the data mark.

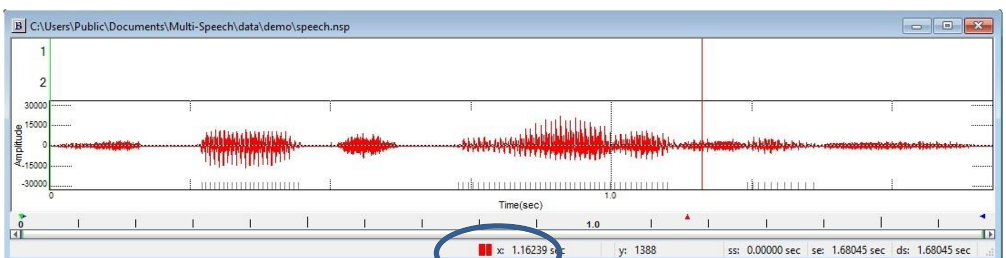


Figure 5. Waveform Editor with Red Data Cursor

Note Some operations, such as audio playback and data display, can be performed on a region of data that is defined relative to the data cursor.

You can also use predefined keyboard shortcuts to move the data cursor.

Use:	In the active window to:
Home	Move the data cursor to the start of displayed data.
End	Move the data cursor to the end of the displayed data.
Left	Move the data cursor one pixel to the left.
Right	Move the data cursor one pixel to the right.
Ctrl+Left	Move the data cursor ten pixels to the left.
Ctrl+Right	Move the data cursor ten pixels to the right.

Data Mark

The Data Mark is a green vertical line that initially appears at the start of the display. The data mark provides a reference location relative to the cursor.

- When you move the data mark away from the start of the file, the x-axis records the distance between it and the data cursor. The letter **R** appears after the x-axis value when the data mark is placed and influencing the x-axis value.
- Some operations, such as data display, can be performed on a region of data that is defined relative to the data mark.

To move the data mark, you can:

- Hold down the [**Ctrl**] + **left click** the desired point.
- Move the mouse pointer to the left of the window where data begins. When the arrow becomes a double-arrow (⬌), **left click** and drag the green line to the desired location.
- **Left-click** the desired point and select **Mark at Cursor** () from the toolbar. This moves the green data mark to the location of the red data cursor.
- Use the **Num +** predefined shortcut to place the data mark at the current cursor location.

Note Only one data mark can exist in a window at any time.

The image below shows the data cursor placed slightly over 0.5 seconds before the red data mark.

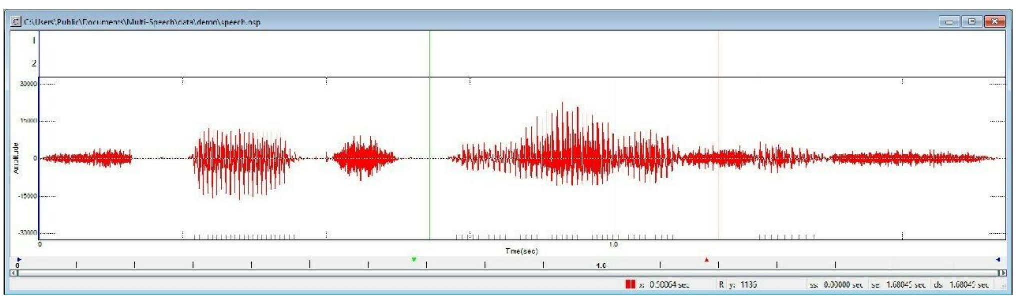


Figure 6. Data Cursor Relative to Data Mark

Segment Marks

Segment Marks are two blue lines that represent the bounds of a data segment.

To place segment markers:

1. **Shift** + **left click** at one of the desired segment bounds.

   A blue line appears and the mouse pointer becomes a double-arrow (⇔).

2. Hold the left mouse button and drag the blue line to the left or right.

   One line moves with the mouse, and one remains where initially placed. The area between the two blue lines makes up the segment.

   To move segment bounds after you place the markers, hover the mouse over the desired line: when the double-arrow returns, hold the left mouse button and move the segment marker.

Note Only two segment markers can exist at one time.

To toggle the display:

1. At the toolbar, select **View Selected Data**.
2. Select:
   - to display data between the segment markers.
   - to display the entire data set.

The image below shows the two blue segment markers around a peak in the waveform.

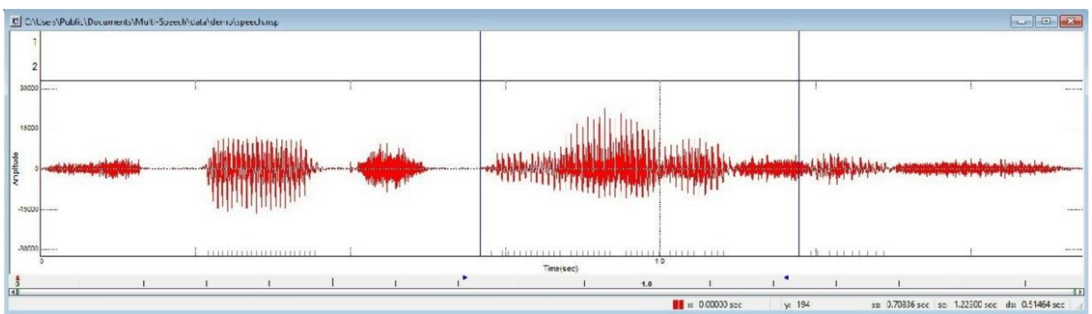


Figure 7. Waveform with Two Blue Segment Markers

The image below shows only the data between the blue segment markers, as shown below.

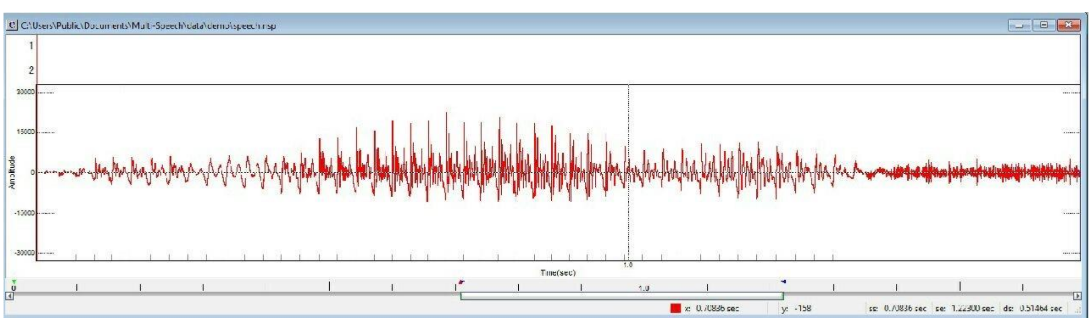


Figure 8. Waveform Showing Only Data Between Segment Markers

4-1-3 **Moving a Cursor**

All cursors can be easily moved to new locations by dragging them with the mouse.

To move a placed cursor (the data cursor, data mark, or selection cursors):

1. In the active window, move the mouse to the location of the cursor you wish to move. The mouse arrow will become a double-arrow (⇹) when over any of the cursors.
2. Hold down the left mouse button and drag the cursor to the desired location within the active window.

4-1-4 **Removing Selection Cursors**

You can remove the selection marks from the active and linked windows.

To remove the selection marks:

1. To remove the selection marks in the active and linked windows, choose Remove Selection Cursors from the Edit menu.
2. The selection start (ss) and selection end (se) boxes on the window status bar normally report the start and end locations of the selected region of data. When selection marks are removed from a window, these boxes are blank. If a scrollbar is displayed in the window, the blue indicators above the scrollbar are removed.
3. Program operations that act on the selection area cannot be performed if selection marks have been removed.
4. At any time, you can re-insert the selection marks by choosing Select All Data from the Edit menu.

4-1-5 **Color Selection Tool**

Two color panels are present as small vertical bars on the bottom of each active window.

These determine the color of the current and next plot in the window. Effective use of the pen tool is important when working with multiple plots per window. Refer to Section 5, Speech Pathology Data Analysis, for more information.

For example, after generating a greyscale spectrogram, you can overlay the formant history in red, the pitch contour in blue, and the energy contour in green to easily distinguish between them.

The screenshot below shows the lower portion of a window containing data with the color selection tool. The color of the currently displayed data always matches that of the first color swatch.

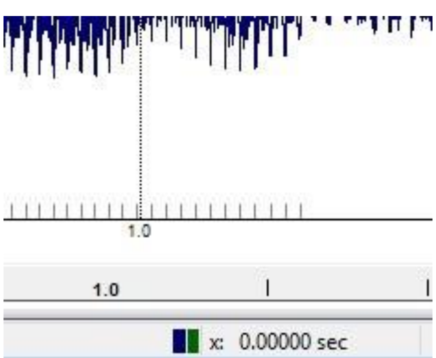


Figure 9. Pen Color Tool

The first, blue swatch, corresponds to the color of the current top plot, which matches the visible waveform displayed in the image. The second color displayed will be used for the NEXT plot in the window.

To change the color of the current active plot:

1. Double-click on the left color swatch at the bottom of the active window.
2. Left click your desired color from the box that appears.

   The topmost graphic in the window is redrawn with the newly selected "active" color.

To set the color of the next plot:

3. Double-click on the right color swatch at the bottom of the active window.
4. Left click your desired color from the box that appears.

   The next plot drawn will use the selected color.

4-1-6 **Keyboard Shortcuts**

CSL Main Program and Multi-Speech come configured with a number of keyboard shortcuts which carry out many of the more common functions. Many expert users carry out much of their interaction with the software through keyboard shortcuts. Refer to *Appendix G, Predefined Keys* for a full list of defined key combinations.

Note Custom hotkeys are not supported in version 4.0. If you reach a screen prompting you to assign a keyboard shortcut, press **Done** to exit without making any changes.

4-2 Manipulating Data

4-2-1 **Data Types**

There are three types of data which exist in the graphics work environment of a program window. These are Waveform Data, Analysis Data, and Transient Data.

Waveform Data

Waveform data provide the basis for all other types of program data. All audio data that are captured by the CSL Main Program and Multi-Speech using analog-to-digital (A/D) conversion are stored in binary format as numerical values. These numerical values can be displayed in graphic format and played back as audio data using digital-to-analog (D/A) conversion. Waveform data, displayed in graphic format, have time represented along the horizontal axis and amplitude displayed along the vertical axis.

In addition to the analysis operations that can be performed on waveform data, it is also possible to perform simple "editing" routines on these data.

Analysis Data

Analysis operations can be performed once waveform data have been displayed in the source window. Analysis data resulting from the analysis operations can be one of the following types:

- LPC-based Frequency Response (LPC)
- LPC Waterfall Array (LPCW)
- FFT-based Power Spectrum (FFT)
- FFT Waterfall Array (FFTW)
- Long-Term Average Power Spectrum (LTA)
- Inverse Spectrum (CEPSTRUM)
- Spectrogram (SPG)
- Formant History (FMT)
- Voiced Period Marks (IMPULSE)
- Pitch Extraction (PITCH)
- Energy Calculation (ENERGY)

The type of analysis data will be reflected in the window title at the top left corner of the window. The title of each analysis type is recorded in the bracketed information above. All analysis data can be saved to a file for later processing or plotting, except for the spectrogram and for waterfall arrays

Note Transient data, the output of an analysis calculation, is not supported by numerical results or statistics. Therefore, the data cannot be saved to a file. The only types of transient data are the spectrogram, the FFT waterfall array, and the LPC waterfall array.

Transient Data

The following audio file formats are supported:

- CSL Signal File format (.NSP)
- Wave Audio File format (.WAV)
- A number of Headerless Audio File formats (.RAW):
  - 16-bit PCM
  - 16-bit PCM (byte swap)
  - 8-bit PCM
  - µ-Law (MU-Law)
  - A-Law
  - Dialogic ADPCM
  - Intel ADPCM
- CSL Signal File Format Features
  - File Extension: NSP
    Maximum Number of Channels: 8
    Tags In Data: YES
    Comment Field: YES

- Wave Audio File Format Features
  - File Extension: WAV
    Maximum Number of Channels: 2
    Tags in Data: NO
    Comment Field: NO
- Headerless Audio File Format Features
  - File Extension: RAW
    Maximum Number of Channels: 1
    Tags In Data: NO
    Comment Field: NO
- The data format and sampling rate must be specified before headerless audio files can be loaded or saved. If the wrong format is specified when opening a raw data audio file, the results are garbage. If the wrong sampling rate is specified, the data are spoken at the wrong speed (i.e., too fast or too slow).
- It is recommended that headerless audio files be stored in separate folders that identify the file type and subfolders that identify the sampling rate (for example, create a "MU-LAW" folder which contains folders named "10000", "11025", etc.).

4-2-2 Viewing a Region of Data

You can view portions of displayed data. At the View menu, select:

- **View → All Data** to show all data or click on the toolbar.
- **View → Selected Data** to show the selected data or click on the toolbar.
- **View → Between Data Mark and Cursor** to show only the data between the green data mark and the red data cursor.
- **View → Start to Cursor** to show only the data from the start to the current data cursor location.
- **View → Cursor to End** to show only the data from the current data cursor location to the end.

4-2-3 Show Next Waveform Channel

By default, the active window displays the first channel of a multi-channel recording. You can toggle between them or display all channels within a file.

To display a different channel in the active window:

1. Ensure that a multi-channel waveform is displayed in the active window.
2. To determine how many channels are contained in the signal and which channel is currently displayed, select **Information on Active Window** from the **Window** menu.
3. To switch the display in the active window to the next channel, select **Show Next Waveform Channel** from the **View** menu.

   If the source window contains a multi-channel signal, you can split a single channel from it for display in an empty active window. This action can be performed for every channel in the multi-channel signal. The signals can be subsequently re-joined. Alternatively, you can display all channels of data in a single window.

To display all channels of signal data in the active window:

1. Ensure that the height of the window is sufficient to display multiple panes of signal data.
2. From the **Options** menu, select **Waveform** to display a Signal Display Options box.
3. If the **Display all channels** checkbox is not selected, click on it to select this option.
4. If the active window contains multi-channel signal data, click the **Apply** button to apply the new setting to the window.
5. Click **OK** to close the Signal Display Options box.

   Note that the active window is not divided into multiple panes if there is only a single channel of signal data in the window.

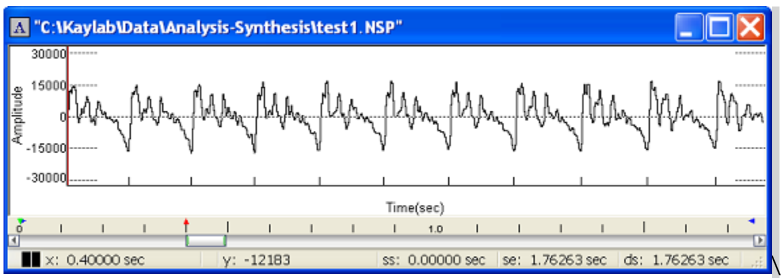


Figure 10. Introduction Window with small range of waveform data

In this example, the scrollbar is much smaller, and is set to only show data between 0.4 and 0.5 seconds, guided by the lines above. The red data mark will be placed at the start of the displayed data.

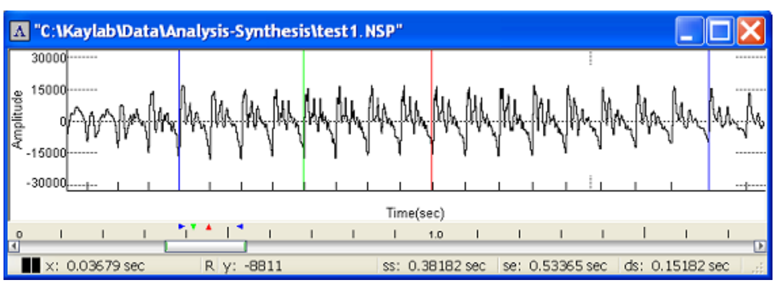


Figure 11. Window with larger range of waveform data.

This image doubles the amount of data shown, displaying the 0.2 seconds between 0.35 and 0.55 of the waveform data. The red data mark remains at its previous location, though as data before Figure 10 is now displayed, the red line appears in the middle of the window, though at the same time as before.

4-2-4 Trimming Sampled Data

You can remove data both inside and outside a specified range, which causes the waveform to be redrawn with new time dimensions. In addition, you can specify that the data within the named range be removed, causing the waveform to be redrawn with the remaining data spliced together.

To trim signal data:

1. Ensure that a waveform is displayed in the source window.
2. Ensure that Window A is active.
3. At the menu, select Edit → Trim Waveform Data to show a list of trimming options.
4. Select:
    - **Remove Signal Outside Selection** to remove data outside the selected region.
    - **Remove Signal In Selection** to remove data in the selected region, with remaining data pasted together.
    - **Remove Signal Start to Cursor** to remove data from the start to the current data cursor location.
    - **Remove Signal Cursor to End** to remove data from the current data cursor location to the end.

    The remaining waveform data are redrawn with new time dimensions.

4-2-5 Data Plot Management

A single window can contain any number of compatible analysis results. Refer to Section 5, Speech Pathology Data Analysis, for details of the many forms of analysis the CSL Main Program and Multi-Speech can conduct.

Note Use different colors to identify different analysis types. See Section 4-1-5, Color Selection Tool, for details on selecting and changing the colors of plotted data.

If a single window contains more than one analysis plot, you can rotate which appears on top. Additional information can be viewed for the uppermost plot, and that plot only can be purged if desired.

To rotate and remove analysis results in the active window:

1. Ensure that the active window contains two or more analysis types.

    Refer to Section 5, Speech Pathology Data Analysis, for details.
2. At the View menu, select **Put Previous Plot on Top**.

    The next set of analysis data is moved to the top, and the window title changes to display the name of the new top plot.
3. Continue clicking Put Previous Plot on Top. Until you reach the analysis you need.

    To view information about the current top analysis, right-click inside the active window and pick Information. To view details about the uppermost analysis, as shown in the screen below. The specific data shown will vary according to the type of analysis plotted on top.

Remove Current (Top) Plot

A window can contain any number of compatible analysis results. If multiple analysis results data are present in a window, you can remove the top analysis data and display the previous data.

Note If the results of only one analysis are in a window, removing the topmost analysis data is equivalent to purging the window.

To remove the topmost analysis results data from the active window:

1. Ensure that analysis results data are present in the active window.
2. Select **Remove Current (Top) Plot** from the **View** menu to remove the current analysis results,

   The topmost analysis results are removed from the window and deleted from the analysis results list. Data from a previous analysis are brought to the top of the list. The window title changes to reflect the current analysis data. Removing the last analysis data from a window is the same as purging the window.
3. Select **Information on Active Window** from the **Window** menu to display information about the current analysis.

   You can also display numerical results and result statistics for the current analysis data. Note that, because spectrogram data are transient, statistics and numerical results are not available.

Note When you overlay multiple analysis results in a window, it can be helpful to display each calculation in a different color.

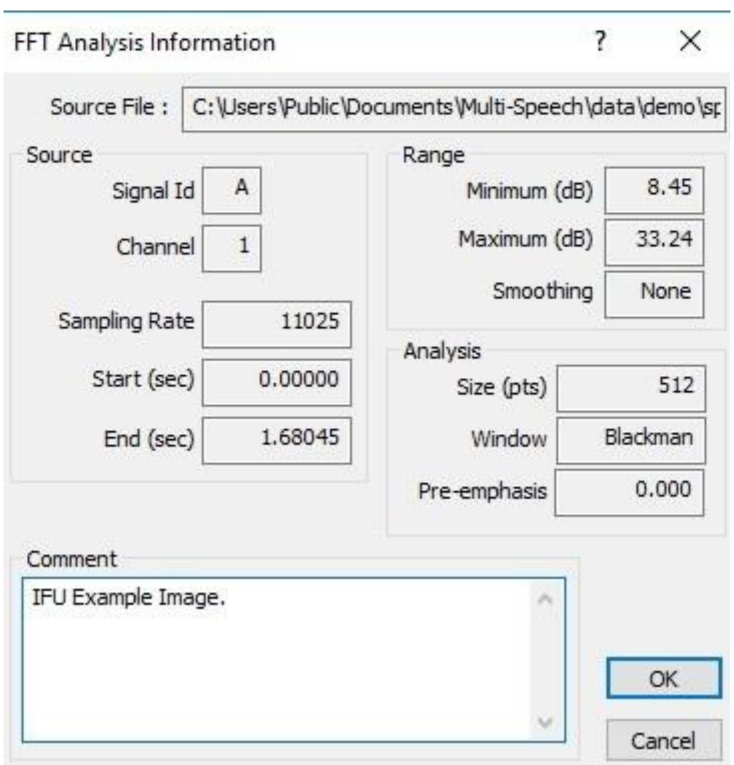


Figure 12. Formant Analysis Information Window

4-3 Recording a Signal

To record a signal:

1. Turn on your microphone
2. At the menu, select **File → New (Record)**

   During recording, the Record button on the bottom of the active window is replaced with a nVU meter and Stop button, and the waveform of the input signal is displayed in the active window. A Scope Window can also be displayed beside the active window if selected under Options, Capture and Waveform

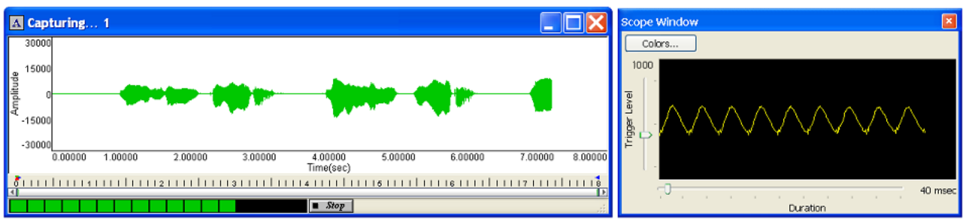


Figure 13. Window A and the Scope Window during waveform capture

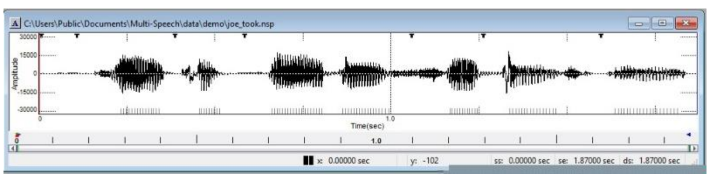


Figure 14. Window Containing Waveform Data

3. Select **File** and **New (Record)**, and say "We were away a year ago."
4. If there is data in in the active window, a confirmation message appears. Click **Yes** to purge the window contents in order to record new data.
5. To stop data capture, press the spacebar, **Enter** or **Stop** on the window status line.

4-3-1 Recording Parameters

Recording parameters are determined by the Capture settings. To alter these settings:

1. Select **Options** from the Main Menu, then **Capture....** A dialog box for setting capture (i.e., record) parameters is presented, as in the following figure.

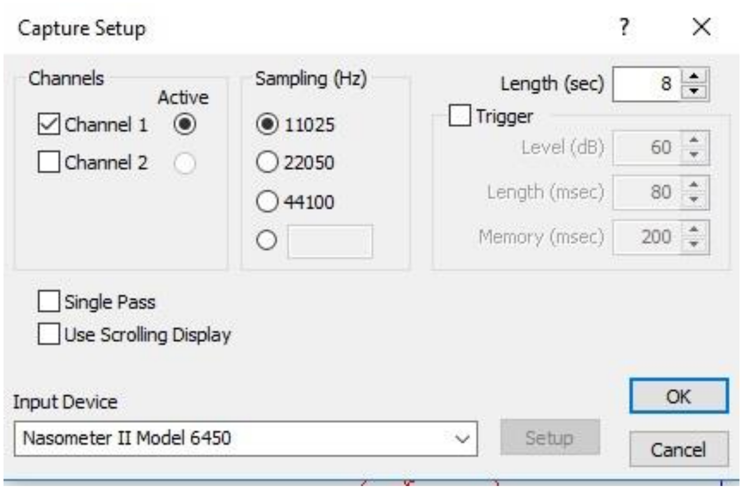


Figure 15. Multi-Speech capture parameters.

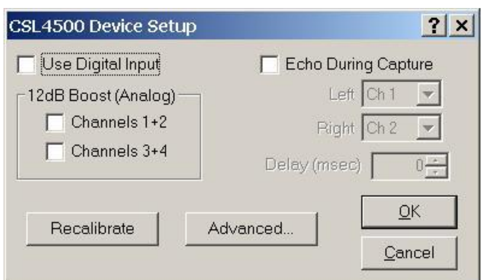


Figure 16. Recording Parameters

4-3-2 Signal Options

The **Options** menu accessed via the **Capture** allows configuring of the following recording parameters:

- **Input Channel(s)** - Specifies the hardware input channel(s).
- **Active Channel** - Select input channel (s) to capture. If **Display all channels** is turned on when capturing a multi-channel signal, the active window is divided into multiple panes during data capture, one for each selected input channel. When capturing only one channel of data, the data from the input channel is automatically monitored.
- **Sampling Rate** - Sets the number of samples per second that will be acquired during analog-to-digital conversion of a signal.
- **Length (sec)** – Sets the desired length of a recording in seconds from 1 to 3,600 (1 hour).
- **Single Pass** – Select Single Pass to stop your recording after the time specified in Length (sec) is reached. Recording will otherwise continue until stopped.
- **Scrolling Display** - If the program is set to display the waveform in the active window during capture, then you can specify a scrolling or a stationary display.

- **Trigger** - Specifies whether data capture begins immediately when Record is selected, or begins when the decibel level selected below is reached.
- **Trigger Level** - In an input trigger is used for data capture, specifies the energy level of the data needed to trigger data capture, in dB. The specified energy level must be maintained for the duration of the trigger buffer (set by **Trigger Length**) for triggering to take effect.
- **Trigger Length** - If an input trigger is used for data capture, specifies the length of the trigger buffer, in msec. This buffer length can be between 20 and 1000 msec, in intervals of 20 msec. Note that the capture length setting must be at least twice as long as the trigger length.
- **Trigger Memory** - If an input trigger is used for data capture, specifies the amount of data prior to triggering that is used for real-time analysis, in msec. **Trigger Memory** must be greater than or equal to **Trigger Length**, and must be less than or equal to half the capture length.

4-3-3 Input Device Options

The lower left of the same Options and Capture Window lets you select the data acquisition device and if using equipment supplied by PENTAX Medical (CSL Users) allows for additional options to be configured.

To select a data acquisition device:

1. At the **Options** menu, select **Capture**.
2. Select the desired input device from the dropdowns on the bottom of the window.
3. If PENTAX Medical supplied CSL box, the **Setup** box will be clickable, and display the options below:
4. If using a PENTAX Medical hardware device, you can set the input device options by clicking the **Setup** box to the right of the **Input Device** dropdown box. Refer to the device options for your PENTAX Medical hardware.

4-3-4 Speak Options

To configure options related to data acquisition:

➢ At the **Options** menu, select **Speak**.

You can set the following Signal data acquisition:

- **Mode** - Selects stereo or mono output mode.
- **Muting** - Specifies if one of the output channels should be muted.
- **Repeat Delay** - Specifies whether to repeat audio output more than once, and if so, how long to pause between repetitions, in msec.
- **Report** - Specifies whether the cursor will scroll through the data during audio output.
- **Splice** - When two ranges of data are selected for audio output, Splice specifies whether to divide the two ranges together so that there is no delay between them, or with a silent pause the length of the gap between selected ranges.

4-3-5 CSL Device Options

For data capture using CSL 4500b hardware, you can set the following device-specific capture options:

To configure device options:

1. At the **Options** menu, select **Capture**.
2. Click **Setup** to the right of the input device dropdown.
3. Select your CSL 4500b from the dropdowns on the bottom of the window.
   The options below will be available to configure

> **Note** CSL 4500b hardware requires that the digital recording device be in play mode before data capture is started, in order for the digital sampling rate to be detected. Refer to Appendix *A, Installation of CSL Main Program and Multi-Speech* for more information on using an external recording device with CSL.

- **Use Digital Input** - Specifies digital input from DAT recorder or other digital recording device with S/P DIF interface capability. If Use Digital Input is enabled, the 12dB Boost (Analog) option is disabled.
- **12 dB Boost (Analog)** - Increases the input level by 12 decibels of sound pressure (dB SPL) for the selected pairs of channels. Note that these settings are disabled if the **Use Digital Input** checkbox is selected.
- **Echo During Capture** - When the **Echo During Capture** checkbox is selected, the input source can be monitored via the output source during data capture. Use this option to listen to the signal during tape input. When the checkbox is clear, the input source cannot be monitored during data capture.
- **Echo Left** - Specifies which channel of input data is echoed to the left output channel when Echo During Capture is turned on. Select one of the available input channels from the list. Note that both the left and right output channels could echo the same input channel of data.
- **Echo Right** - Specifies which channel of input data is echoed to the right output channel when Echo During Capture is turned on. Select one of the available input channels from the list. Note that both the left and right output channels could echo the same input channel of data.
- **Echo Delay** - Sets the delay duration, in msec, when Echo During Capture is turned on. The delay can be set from 0 msec to a maximum of 1000 msec, in increments of 1 msec. Type a value in the edit box or click the up arrow or down arrow in the spinner box to increase or decrease the current setting in increments of 1 msec.
- **Recalibrate** - Used to recalibrate DC offsets of the A/D and D/A converters. Calibration occurs automatically when the driver first loads. Recalibration is recommended 15 to 30 minutes after your computer has been turned on.

4-4 Listening to a Signal

The available speak operations include speaking part or all of the signals.

1. To play all of the signal, select **Speak** on the Main Menu, then **All Data**. You will hear the entire stored signal spoken through the multimedia sound system.
2. During data playback, the active window status line is replaced with a Progress meter, a VU meter, a **Stop** button, and a **Pause** button. The data cursor can move through the waveform during audio output, and a Scope Window can be displayed beside the active window, depending on the audio playback parameters and signal display options.

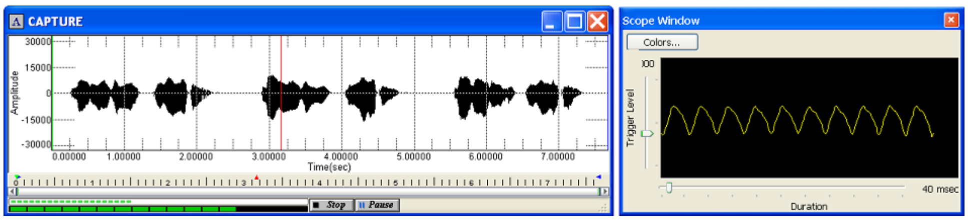


Figure 17. Figure 4.1: Window A and the Scope Window during audio playback.

Note To toggle the Scope Window, select **Window → Options → Waveform**.

3. Next, select **Speak**, then **Selected Data**. This will speak the portion of data selected (and highlighted) from the signal in the active window. Alternatively, you can use [F4] to speak only the selected portion.

4-4-1 Saving a Signal

The CSL Main Program and Multi-Speech support several audio file formats. To save the recorded waveform data:

1. Click on the title of Window A to activate it.
2. Click **File** then select **Save** or press the **[Ctrl+S]** keys.
3. A Save As box is displayed.

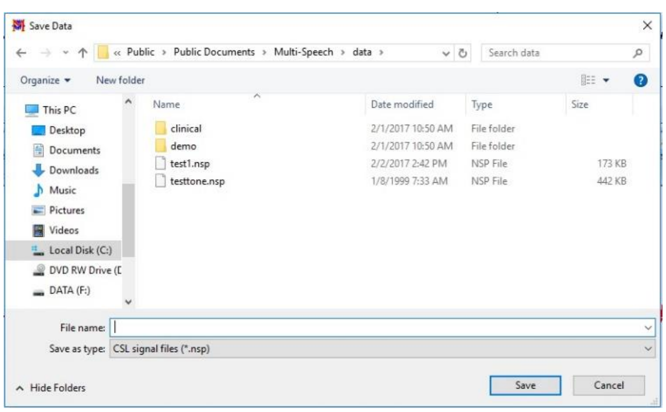


Figure 18. Save As dialog box.

The default file format is a CSL signal file (*.NSP). Audio only can be saved to RAW and WAV formats, but analysis, tags, and channels beyond two will not be captured. Use the NSP format for all files you intend to use with CSL Main Program, Multi-Speech, or other PENTAX Medical Speech Software.

4-4-2 Data Types

Three types of data appear or can bbe generated in the application, Waveform Data, Analysis Data, and Transient Data.

Waveform Data

Waveform data is the basis from which analysis and transient data are drawn, a visual display of the sound captured without modification.

Analysis Data

Analysis operations can be performed once waveform data have been displayed in the source window. Analysis data resulting from the analysis operations can be one of the following types.

- LPC-based Frequency Response (LPC)
- LPC Waterfall Array (LPCW)
- FFT-based Power Spectrum (FFT)
- FFT Waterfall Array (FFTW)
- Long-Term Average Power Spectrum (LTA)
- Inverse Spectrum (CEPSTRUM)
- Spectrogram (SPG)
- Formant History (FMT)
- Voiced Period Marks (IMPULSE)
- Pitch Extraction (PITCH)
- Energy Calculation (ENERGY)

The type of analysis data will be reflected in the window title at the top left corner of the window. The title of each analysis type is recorded in the bracketed information above. All analysis data can be saved to a file for later processing or plotting, except for the spectrogram and for waterfall arrays.

Transient Data

The only types of transient data are the spectrogram, the FFT waterfall array, and the LPC waterfall array. Transient data, which are the output of an analysis calculation, are not supported by numerical results or statistics. Therefore, the data cannot be saved to a file.

Audio File Formats

The following audio file formats are supported:

- CSL Signal File format (.NSP)
- Wave Audio File format (.WAV)
- A number of Headerless Audio File formats (.RAW):
  - i) 16-bit PCM
  - ii) 16-bit PCM (byte swap)
  - iii) 8-bit PCM
  - iv) μ-Law (MU-Law)
  - v) A-Law
  - vi) Dialogic ADPCM
  - vii) Intel ADPCM
- CSL Signal File Format Features
  - File Extension: NSP
    Maximum Number of Channels: 8
    Tags In Data: YES
    Comment Field: YES
- Wave Audio File Format Features
  - File Extension: WAV
    Maximum Number of Channels: 2
    Tags in Data: NO
    Comment Field: NO
- Headerless Audio File Format Features
  - File Extension: RAW
    Maximum Number of Channels: 1
    Tags In Data: NO
    Comment Field: NO

The data format and sampling rate must be specified before headerless audio files can be loaded or saved. If the wrong format is specified when opening a raw data audio file, the results are garbage. If the wrong sampling rate is specified, the data are spoken at the wrong speed (i.e., too fast or too slow).

It is recommended that headerless audio files be stored in separate folders that identify the file type and subfolders that identify the sampling rate (for example, create a “MU-LAW” folder which contains folders named “10000”, “11025”, etc.).

4-4-3 Loading Saved Data from a File

Audio files in NSP format, WAV, and RAW can be opened and analyzed in the CSL Main Program and Multi-Speech.

To load and review signal information for a saved file:

1. At the Window menu, select New to open a new, empty window.

   Files can be loaded into any Window, though doing so in one containing data will prompt you to confirm if you wish to purge the window and replace with the saved data.

2. Navigate to the desired file, or if familiarizing yourself with the application, the sample file “joe_took.nsp” in the folder data and subfolder demo.

3. Confirm the name of the file you opened appears in the blue header bar of the active Window, and that its waveform pattern appears inside the Window. In the image below, the file “joe_took.nsp” is open and ready for use.

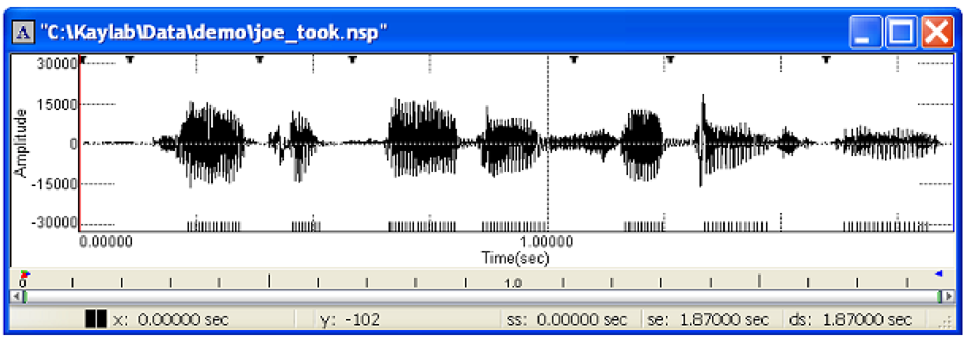


Figure 19. The demo file “joe_took.nsp,” loaded from disk.

4-4-4 **Signal Information**

To view details about a file or recording including channel specifications, visibility of IPA Transcription and Voiced Impulse Marks:

- Right click within the active window and select Information to view the file's Signal Information, shown below for "joe_took.nsp".

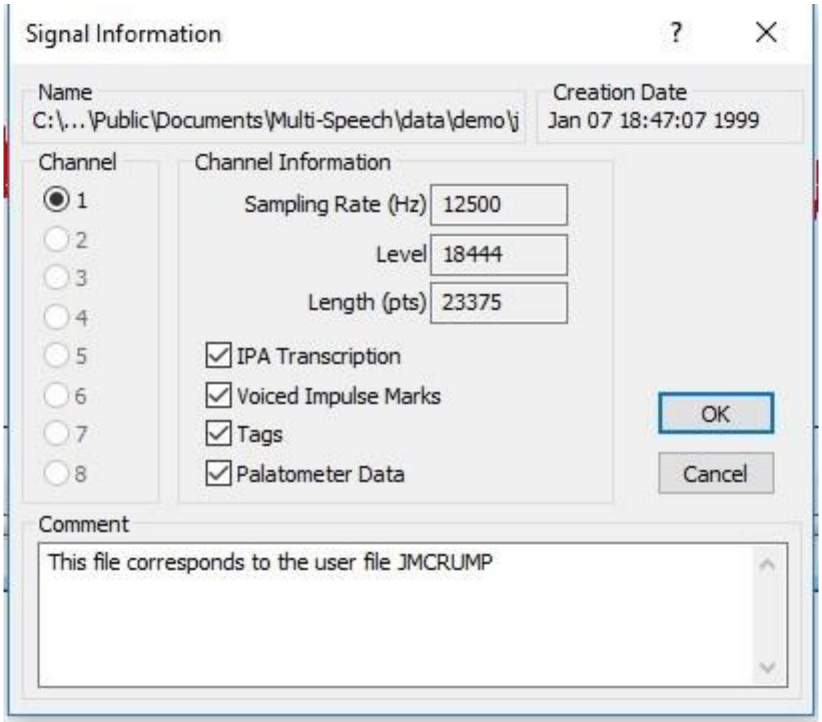


Figure 20. Signal Information window for "joe_took.nsp"

If you speak this file, you will hear a male voice saying, "Joe took father's shoe bench out."

4-4-5 **One-Click Speak**

The playback cursor lets you begin playing a recording by clicking the desired point within the waveform.

To Speak data using the playback cursor.

1. Do one of the following:
   - At the **Speak** menu, select **Hold Mouse Down to Speak**.
   - At the toolbar, click the Speak from Mouse Mode toolbar button .

     The data cursor changes to a "playback" cursor, which looks like a megaphone. The toolbar button will appear pressed down while Speak from Mouse Mode is active.
2. Press and hold down the **Left** mouse button in the active window to speak the waveform data associated with the window.
3. Audio output begins from the location of the mouse click

4-4-6 Speak Ranges

You can Speak (play) recorded waveform data in whole or in specified ranges beginning from various points within the active window.

To review Speak Options before playing:

1. At the **Options** menu, select **Speak**.

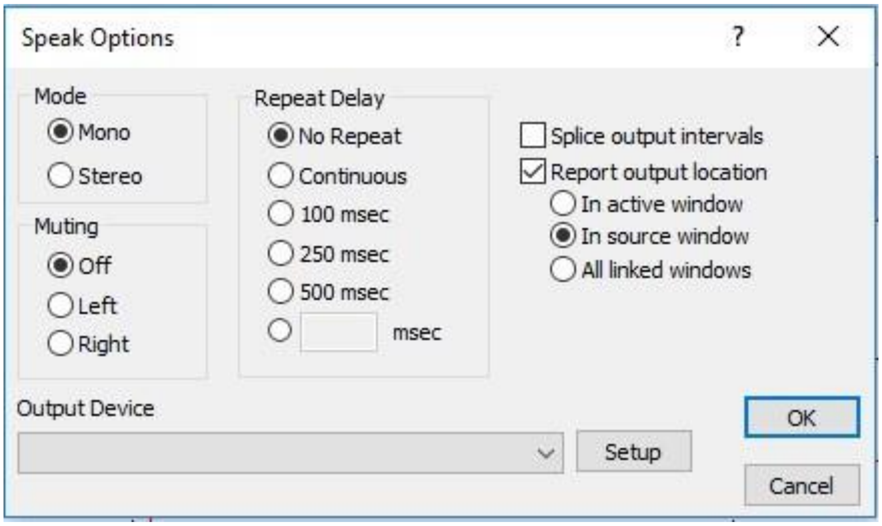


Figure 21. Speak Options Menu

2. Select an output device and edit parameters as needed.

   Setup provides additional playback options which vary based on the output device being used.

To speak all data in the active window:

- At the Speak Menu, click **All Data**. The whole of the data in the active window will play.

To speak only the selection between the blue segment markers:

- At the Speak Menu, click **Displayed Data**.

  The section identified by blue segment mark plays.

To speak the waveform data currently displayed in the active window:

- At the Speak Menu, click **All Data.**

  The whole of the data in the active window will play.

To speak the data from the start to the current data cursor location:

- At the Speak menu, click From Start to Cursor.

4-4-7 Spliced and Gated Data

Data can be played with no pause between the segments (spliced), or played with a pause equal to the length of the excluded data (unspliced or gated). This section covers ranges and the splicing and gating of audio data.

To identify and speak two ranges of data:

1. Place the two blue segment markers around a range of data you wish to exclude.

   The area not included in the selection makes up your two ranges.

2. Choose to Speak the data spliced (no pause) or gated (pause equal to omitted section)

   - To speak the data without a pause, at the Speak menu, choose **All But Selected (Spliced)**. Both sections will play back-to-back.
   - To speak the data with a pause (gated), at the Speak menu, choose All But Selected (Unspliced). A blank section equal in length to the omitted data takes its place when you Speak the data.

3. To return the mouse to normal data cursor mode do one of the following:

   - At the Speak menu, select Hold Mouse Down to Speak to clear the checkbox.
   - At the toolbar, click the Speak from Mouse Mode button while it is in the pressed state.

     The normal mouse cursor returns, and the is no longer depressed.

Note Speak from Mouse Mode must be activated and deactivated for each window that supports speech output.

4-4-8 Output Device Options

The output device can be a standard multimedia audio card, or it can be one of several audio devices provided by PENTAX Medical. Output device options are set separately for each hardware type. Specify the output device by selecting an available hardware device from the Output Device dropdown box in the Signal D/A Options dialog box.

If you are using the PENTAX Medical CSL 4500b hardware device, you can set the output device options by clicking the Setup box to the right of the Output Device dropdown box. If using a multimedia audio card or any other PENTAX Medical hardware device, the Setup box to the right of the Output Device box is disabled.

For data output using CSL 4500b hardware, you can set Digital Output, which allows selection of analog output or digital output to a digital recording device with file transfer or S/P DIF interface capability when using the CSL 4500b hardware. Note that if digital output is selected, the sampling rate of the signal data must be compatible with the digital recording device. Typical rates are 32000, 44100 and 48000 samples per second.

4-5 Generating a Waveform

The CSL Main Program and Multi-Speech allow you to create a waveform signal, with a number of parameters specified to control the waveform characteristics, and to display the waveform in the active window.

To generate a waveform:

1. To create a waveform, choose **Generate Waveform** from the **File** menu.
2. If the active view is not empty, a warning is displayed that all data will be lost, and you are asked if you wish to continue. Select **Yes** to delete the data displayed in the active window and begin signal generation. If you do not want to lose the data in the active window, select **No**. You can now activate a different window, or create a new window, then return to Step 1 to begin signal generation in the new active window.
3. A dialog box is displayed in which you can select the signal characteristics.
4. Once you have selected the desired waveform characteristics, click the **OK** button. The generated waveform will be displayed in the active window.
5. You can listen to the signal, and optionally save the signal data in an audio file.

4-5-1 Characteristics of Generated Signal

- **Signal Type** - Selects the kind of waveform to be generated, which can be a sine wave, square wave, triangular wave, sawtooth wave, or White Noise.
- **Start and End Amplitude** - Selects the peak amplitude at the beginning and end of the waveform. Peak amplitude values are then calculated linearly between the start and end values.
- **Start and End Frequency** - Sets the starting and fundamental frequency in Hertz of the periodic waveform to be created. These values are ignored if the waveform type is White Noise. The fundamental frequency is then calculated linearly between the selected start and end frequencies**.**
- **Sampling Rate** - Sets the sampling rate of the waveform, in number of samples per second.
- **Phase Angle** - Sets the starting phase angle of the waveform, in degrees between 0 and 359.
- **Duration** - Sets the length of the signal to be created, specified in seconds or in number of sampled data points.

4-6 Printout of the Application Window

You can send the current graphics information in the work area to a printer.

To generate a screenshot:

1. From the **File** menu, select **Print/Save Graphic Images**, then **Print Full Screen Image**.
2. A Screen Print dialog box is displayed on the screen. You can add a header to the printout by clicking the Header checkbox, then entering the desired text in the Header box. Similarly, you can add a footer to the printout by clicking the Footer checkbox and entering the desired text in the Footer box.
3. Click the Setup button to access a Print Setup dialog box, where you can specify the printer to use, the page orientation, the paper size and the paper source. Click Font to specify the font to use for the header and/or footer.
4. After entering any desired header or footer information, specifying the font and setting up the printer, click Print to send the graphics to the printer. Click Cancel to abort the operation.

4-6-1 Print High-Resolution Image of Active Window

You can send a high-resolution graphic image of the active window to a printer.

To print the active window:

1. From the **File** menu, select **Print/Save Graphic Images**, then **Print Active Window Image**.

   A Print Setup box is displayed.
2. Specify the printer, paper size, and page orientation, then click **OK** to dump a graphic image of the contents of the active window to the printer, or click **Cancel** to abort the operation.
3. The high-resolution graphic image is centered on the printed page.

4-6-2 Save High-Resolution Image of Active Window

You can save a high-resolution graphic image of the active window to a file. The CSL Main Program and Multi-Speech support a number of graphic file formats, including bitmap (.bmp), the Joint Photographic Experts Group (JPEG) format (.jpg); graphics interchange format (.gif), and portable network graphics (.png).

To save an image of the active window:

1. From the File menu, select Print/Save Graphic Images, then Save Active Window Image.
2. A Save Window Image dialog box is displayed on the screen.
3. Access the folder to save the image file in, using the Create New Folder feature if necessary.
4. You can save the graphic in BMP, JPG, GIF, or PNG file format. Select the type of file you wish to save from the Save As Type box.
5. Enter a name in the File Name box.

6. The size of the saved image is reported at the bottom of the dialog box, in pixels, inches, or centimeters (cm). Optionally adjust the size of the graphic by modifying the Height and/or Width values. Note that these values are constrained to stay in their original proportion to one another. If you adjust the height of the image, the width changes in relation to the original aspect ratio, and vice versa. Alternatively, when the image size is reported in inches or centimeters, adjust the size of the saved file by increasing or decreasing the dots per inch (DPI) resolution. A smaller resolution produces a smaller graphic image, and a larger resolution produces a larger graphic image.
7. Click the Save button to save the file or select Cancel to exit the file saving routine without saving the file.

4-7 Configuration Files

Configuration files allow you to save and switch between commonly used arrangements of windows and parameter settings. You can always revert CSL and Multi-Speech to their factory interface settings as desired. All changes to the UI are stored in a temporary location, which can be saved as a configuration file at any time.

4-7-1 Save Configuration to User File

Configurations can be saved to the user files which opens on launch, or in a custom named file that can be loaded as desired. To save a configuration to the user file:

1. Ensure that "USER.XML" appears at the lower right of the application window, next to where the source and active windows are listed.
    - If a different filename is displayed, exit the application and then restart. The "USER.XML" configuration file is loaded at launch and will display after restarting the software.
2. At the **File** menu, select **Configuration Files**, and **Save (Update) the User Configuration File**.

   The current configuration will be saved to the user file and will appear each time the application is launched. Exit and restart the application to ensure your changes are saved.

   Note You will receive an error message if the currently active configuration file is not USER.XML. In this event, exit and restart the software, which will load the default user file.

4-7-2 Activating Configuration Files

Note: When you reset the CSL Main Program or Multi-Speech, existing windows are deleted and all data are lost. Before executing any of these commands, you should save any data that you want available at a later time to disk storage.

At any time, you can reset the CSL Main Program or Multi-Speech to the default (factory delivered) configuration:

➢ At the **File** menu, select Configuration Files, Reset User Configuration to Factory Settings.

This will delete both the permanent and temporary copies of the user configuration file, if it exists, before redrawing the work area with the default layout. A new temporary file is created to store all parameter changes made, which can be written to a permanent user configuration file.

You can reset the CSL Main Program or Multi-Speech to the work area layout and parameter settings defined in the user configuration file, if it exists.

➢ Select **Reset (to the User Configuration)** from the **File** menu.

The temporary user file is deleted and the user configuration file becomes the active initialization file. A new temporary user file is created to store all parameter changes made, which can be written to a permanent user configuration file.

If you have created other configuration files, you can reset the CSL Main Program or Multi-Speech to any saved configuration:

➢ Select **Configuration Files, Reset to an Alternate Configuration** from the **File** menu.

The named configuration file becomes the active file, and the configuration file box on the status line is updated to display the name of this file. Any subsequent changes to the work area layout or parameter settings are written to a temporary copy of this active file until specifically saved.

In each case, a warning message is displayed before the CSL Main Program and Multi-Speech configuration is reset. Click **Yes** to continue with the operation; click **No** to cancel the request to reset.

4-7-3 Saving Configuration Files

Note that all parameter setting changes you make are saved in a temporary initialization file until specifically written to the active file, which is identified in a box on the status line. Thus, you can discard the changes when the session ends, so that each session starts from the same configuration.

To save the settings in the temporary configuration file:

- When the CSL Main Program and Multi-Speech start, a temporary copy of the active configuration file is created. The active file is usually the user configuration file. When the work area layout or command parameter settings are changed, these changes are written to this temporary file.

- You have the option of saving changes stored in the temporary user file to the permanent user configuration file. Select **Configuration Files, Save (Update) the User Configuration File** from the **File** menu. The current window layout and parameter settings are copied from the temporary file into the user configuration file. Note that if the user configuration file is not active, an error message is returned.
- You can create a number of configuration files, each designed to configure the CSL Main Program and Multi-Speech for a specific task. These configuration files can be used, for example, to define the work area layout and program variables for use in a macro.

3. Save the changes in the temporary file to a configuration file other than the active file by selecting **Configuration Files, Save a New Alternate Configuration File** from **File** menu. Enter a filename and click S**ave** to store the current settings in that file.

4-7-4 **Default Configuration**

The default program configuration is written to the registry when the CSL Main Program and Multi-Speech is installed. These factory settings are never altered by the CSL Main Program and Multi-Speech. When you run the CSL Main Program and Multi-Speech, all parameter setting changes made in the session are stored in temporary memory. You have the option of saving these changes to a permanent user configuration in the registry.

If you do not save the new settings selected during a session, the changes are discarded when you exit the CSL Main Program and Multi-Speech. This allows each session to start from the same configuration.

Each time a command is executed, the CSL Main Program and Multi-Speech first searches for any required parameter settings in the temporary memory store. If the required settings are not found, the CSL Main Program and Multi-Speech looks next in the user settings, if it exists, then finally in the factory settings.

To save the current settings for use in the future:

➢ Select **File** from the Main Menu. Then select **Save (Update) the User Configuration**.

The current program settings are saved to a user configuration section. These settings are now available for use in future sessions.

4-7-5 **Restore the Factory Settings**

To restore CSL Main Program or CSL to the default factory settings:

➢ At the File menu select Reset User Configuration to Factory Settings.

The user configuration settings and the session settings held in temporary memory are discarded.

4-8 Adjust Signal Offset

You can remove any DC offset, or "float," that can be generated by a multimedia audio card. The DC offset value can be calculated automatically from the waveform data and subtracted from the amplitude values in the data, or a manually specified offset value can be applied.

Automatically calculate and adjust the DC offset:

1. Capture waveform data into the active window.
2. Ensure that the offset adjustment parameters are set for automatic calculation of the DC offset value. This can be done by selecting **Editing**, **Signal Offset** from the **Options** menu to display a box in which you can view and change these parameters.
3. To compute and subtract the DC offset, select **Adjust Signal Offset** from the **Edit** menu, and then select the range of waveform data to use for the calculation and adjust. This can be **All Data**, the **Selected Data** or the **Displayed Data** in the active window.
4. The waveform in the specified range is examined to determine the offset in that range, and this offset value is subtracted from the amplitude values in the waveform.

Manually adjust the DC offset:

1. Capture waveform data into the active window.
2. Ensure that the offset adjustment parameters are set to apply a manually specified DC offset value. This can be done by selecting **Editing**, **Signal Offset** from the **Options** menu to display a box in which you can view and change these parameters.
3. To adjust the DC offset, select **Adjust Signal Offset** from the **Edit** menu, and then select the range of waveform data to use for the calculation and adjust. This can be **All Data**, the **Selected Data** or the **Displayed Data** in the active window.
4. The manually set offset value is added to the amplitude values in the specified range of the waveform. Note that amplitude values will

5 Speech Pathology Data Analysis

This section discusses the many forms of data analysis you can conduct with CSL and Multi-Speech and how to properly conduct them. The various options and configurations for each analysis are covered prior to the analysis itself.

5-1 LPC Frequency Response

Before conducting an LPC Analysis, ensure the options are set to meet your needs:

1. At the **Options** menu, select **Analysis**, then **LPC Frequency Response**.
2. In the window which appears, the options below can be configured:
   - Frame Length - Specifies the length of the frame of data to be analysed when performing pitch-asynchronous analysis. During pitch-synchronous analysis, this variable is used for data in voiceless regions only, and the voiced regions are analysed using a frame length determined by the voiced period marks.
   - Display Range (X-axis) - Specifies the frequency range (X-axis) over which the frequency response will be displayed. You can choose to display the frequency range as a percentage of the Nyquist Frequency or as specific upper and lower frequency values.
   - Filter Order - Selects the filter order, or the number of LPC coefficients to be applied to the analysis.
   - Pre-Emphasis - Determines the application of pre-emphasis and the value of the pre-emphasis factor. A value of 0 means no pre-emphasis.
   - Display Range (Y-axis) - Specifies the display range setting along the vertical axis in decibels of sound pressure level (dB SPL).
   - Analysis Method - Selects the LPC analysis method. You have a choice of the autocorrelation or covariance methods.
   - Window Weighting - Controls the application of window weighting to a frame of sampled data that is to be processed during LPC analysis. Window weighting is applied to reduce the amplitude of the signal as it approaches a frame boundary. If a rectangular window is selected, its effect is to apply no window weighting. Window weighting is recommended when using the autocorrelation method, and the rectangular window is recommended when the covariance method is applied.
   - Pitch-Synchronous - Selects calculation of LPC framing from voiced period marks that are present in the data or from a fixed frame length.
   - Frequency Report - specifies whether to report the x-axis value at the cursor location in Hz only, Hz and Bark, or Hz and Mel.

To conduct an LPC Frequency Analysis:

1. Ensure that a waveform is displayed in the source window. The active window must either be empty or contain frequency response (FFT or LPC) data:
2. If voiced period marks (impulse marks) are present in the data, you can perform pitch-synchronous LPC analysis. In this case, the data between two voiced period marks are fed to the LPC processor for analysis. Otherwise, frames of data of a fixed length are used.
3. Before generating the frequency response, set up the LPC analysis parameters. This can be done by selecting Analysis, LPC Frequency Response from the Options menu to display a box in which you can view and change these parameters.
4. Choose LPC Frequency Response, LPC Frequency Response at Cursor from the Analysis menu to create a frequency response of the data at the cursor location.
5. The frequency response for the specified location is drawn in the active window, and the range of data (frame) used to produce the LPC is highlighted in the source window. Numerical results and result statistics can now be displayed, and optionally printed and saved, or copied to the clipboard then pasted into a spreadsheet.

5-2 LPC Waterfall Analysis

Before conducting an LPC Waterfall Analysis, ensure the options are set to meet your needs:

1. At the **Options** menu, select **Analysis**, then **LPC Waterfall Analysis**.
2. In the window which appears, the options below can be configured:
   - **Analysis Method** - Specifies the LPC analysis method. Choices are the Autocorrelation method or the Covariance method.
   - **Filter Order** - Specifies the filter order, or number of LPC coefficients to be applied to the analysis.
   - **Pitch-Synchronous** - Specifies calculation of LPC framing from voiced period marks (voiced period marks) that are present in the data or from a fixed frame length. If pitch-synchronous analysis is selected and voiced period marks are in the source signal data, pitch-synchronous LPC values are computed; otherwise, fixed-frame LPC analysis is performed, with the size of the analysis frame determined by the setting for Frame Length.
   - **Pre-Emphasis** - Determines the application of pre-emphasis and the pre-emphasis factor. If a value of 0 is entered, no pre-emphasis is applied.
   - **Window Weighting** - Controls the application of window weighting to each frame of sampled data that is processed during LPC analysis. Window weighting is applied to reduce the amplitude of the signal as it approaches a frame boundary. If a rectangular window is selected, its effect is to apply no window weighting. A Blackman or Hamming window is recommended for speech processing.

LPCW Options: Framing Tab

From the Framing Tab, set the following LPCW options:

- **Frame Length** - Specifies the length of each frame of data to be analyzed when performing fixed frame (pitch-asynchronous) analysis. Frame length can be expressed in milliseconds or in number of sampled data points. During pitch-synchronous analysis, this variable is used for data in the voiceless regions only, and the voiced regions are analyzed using a frame length determined by the voiced period marks in the data.
- **Frame Advance** - Specifies the frame advance for fixed-frame LPC calculation. The frame advance can be expressed in milliseconds or in number of sampled data points. Frame advance is independent of frame length, so the analysis results can be for contiguous or overlapping frames, or can provide a small sample of LPC information for the data.

LPCW Options: Display Tab

From the Display Tab, set the following LPCW options:

- **Display Range (X-Axis)** - Specifies the frequency range (x-axis) over which the LPC frequency responses are displayed. The frequency range can be displayed as a percentage of the Nyquist Frequency or as specific upper and lower frequency values.
- **Display Range (Y-Axis)** - Controls the display range along the y-axis, in decibels of sound pressure (dB SPL).
- **Skew Angle** - Specifies the angle of the waterfall display to skew to the left or to the right. The window is divided into four quadrants of equal size. When set to skew right, the start frame is drawn in the bottom left quadrant and subsequent frames are drawn behind it and angled up and to the right. When set to skew left, the start frame is drawn in the bottom right quadrant and subsequent frames are drawn behind it and angled up and to the left.
- **Start Frame** - Specifies whether the first or last frame of the analysis results is plotted at the front of the waterfall array. Frames are plotted consecutively on the z-axis from first to last or from last to first, with the start frame plotted in the lower left or right quadrant of the window, depending on the setting for Skew Angle.

To create an LPC Waterfall Display:

1. Ensure that a waveform is displayed in the source window. The active window must be empty prior to command execution.
2. If voiced period marks (impulse marks) are present in the waveform data, you can perform pitch-synchronous analysis. In this case, the data between two voiced period marks is used for analysis. Otherwise, frames of data of a fixed length are used.
3. Before generating the LPC waterfall display, set the LPCW analysis parameters. To do this, select Analysis, LPC Waterfall from the Options menu to display a box in which you can view and change these parameters.

4. To generate the waterfall display, choose LPC Waterfall from the Analysis menu. A submenu appears in the work area giving you the option to generate the LPC waterfall display from all the source data (All Data), a selected region of the source data (Selected Data), or the displayed data (Displayed Data). Select the range of data you want to analyze.
5. During the analysis, a dialog box appears in the work area, telling you which frame is being processed and the total number of frames that will be processed, and giving you the option to Stop Processing.
6. The LPC Waterfall display for the specified range is drawn in the active window, and the first frame of the analysis results is highlighted. Depending on the setting for LPCW Start Frame, this first frame can be plotted at the front or back of the array. The values in the x-axis, y-axis, and z-axis boxes on the window status line report the frequency (Hz), energy (dB), and time (sec) values at the data cursor in the highlighted frame. Use the [Up] arrow key to scroll forward in time on the z-axis, highlighting each frequency response (from first to last) in turn, and use the [Down] arrow key to scroll backward in time on the z-axis. Alternatively, click the mouse on the z-axis (time axis) to highlight a specific frame.
7. The output of the LPC Waterfall analysis is not supported by numerical results or result statistics.

5-3 FFT Power Spectrum

From the Options menu, select Analysis, then FFT Power Spectrum. You can set the following FFT Analysis options:

- **Analysis Size** - Specifies the number of coefficients in the FFT to be computed during analysis.
- **Window Weighting** - Controls the application of window weighting to a frame of sampled data that is to be processed during FFT analysis. Window weighting is applied to reduce the amplitude of the signal as it approaches a frame boundary. If a rectangular window is selected, its effect is to apply no window weighting. A Blackman or Hamming window is recommended for speech processing.
- **Smoothing** - The power spectrum can be displayed in block mode or point mode, with a smoothing factor optionally applied to the spectral coefficients in point mode. Smoothing the energy in the frequency domain of the power spectrum is done in order to suppress any harmonic ripple present in the signal. The degree of smoothing to be applied depends upon the harmonic separation in the signal and upon the frequency resolution of the power spectrum.
- **Pre-Emphasis** - Determines the application of pre-emphasis and the value of the pre-emphasis factor. If a value of 0 is entered, no pre-emphasis is applied.
- **Frame Size** - Specifies the length of the frame of data to be analyzed. This can be equal to the number of FFT coefficients (analysis size), can be delineated by voiced period marks (pitch-synchronous), or can be another value expressed in number of sampled data points or in milliseconds. The frame size cannot be greater than the analysis size. If the selected frame size is less than the FFT analysis size, the frame is padded with zeros.
- **Display Range (X-Axis)** - Specifies the frequency range (X-axis) over which the power spectrum will be displayed. You can choose to display the frequency range as a percentage of the Nyquist Frequency or as specific upper and lower frequency values.
- **Display Range (Y-Axis)** - Controls the display range setting along the Y-axis, in decibels of sound pressure (dB SPL). If normalization is on, this parameter is ignored.
- **Frequency Report** - specifies whether to report the x-axis value at the cursor location in Hz only, Hz and Bark, or Hz and Mel.

To create a power spectrum:

1. Ensure that a waveform is displayed in the source window.

   The active window must be empty or contain frequency response (FFT or LPC) data prior to command execution.

2. If voiced period marks (impulse marks) are present in the data, you can perform pitch-synchronous analysis.

   In this case, the data between two voiced period marks is used for analysis. Otherwise, frames of data of a fixed length are used.

3. Before generating the power spectrum, set the FFT analysis parameters. To do this, select **Analysis**, **FFT Power Spectrum** from the **Options** menu to display a box in which you can view and change these parameters.

4. To generate the power spectrum, choose **FFT Power Spectrum**, **FFT Power Spectrum at Cursor** from the **Analysis** menu to create a discrete power spectrum of the data at the cursor location.

   The power spectrum for the specified location is drawn in the active window, and the range of data (frame) used to produce the spectral slice is highlighted in the source window. Numerical results and result statistics can now be displayed, and optionally printed and saved, or copied to the clipboard then pasted into a spreadsheet.

5-4 FFT Waterfall Analysis

From the Options menu, select Analysis, then FFT Waterfall. There are a number of FFTW analysis and display parameters that can be set by the user. Note that the FFT Waterfall Setup box contains three (3) separate tabs. Click on the appropriate tab for the options you want to set, and then set the desired parameters.

FFTW Options: Analysis Tab

From the Analysis Tab, set the following FFTW options:

- **FFT Analysis Size** - Specifies the number of coefficients in the FFT to be computed during analysis. The FFT Analysis Size must be greater than or equal to the Frame Length.
- **Pre-Emphasis** - Determines the application of pre-emphasis and the pre-emphasis factor. If a value of 0 is entered, no pre-emphasis is applied.
- **Smoothing Level** - The power spectra in the waterfall array can be displayed in Block Mode or Point Mode, with a smoothing factor optionally applied to the spectral coefficients in Point Mode. Smoothing the energy in the frequency domain of a power spectrum is done in order to suppress any harmonic ripple present in the signal. The degree of smoothing to be applied depends on the harmonic separation in the signal and on the frequency resolution of the power spectrum.
- **Window Weighting** - Controls the application of window weighting to each frame of sampled data that is processed during FFT analysis. Window weighting is applied to reduce the amplitude of the signal as it approaches a frame boundary. If a rectangular window is selected, its effect is to apply no window weighting. A Blackman or Hamming window is recommended for speech processing.

FFTW Options: Framing Tab

From the Framing Tab, set the following FFTW options:

- **Frame Advance** - Specifies the frame advance for fixed-frame FFT calculation. The frame advance can be equal to the number of coefficients in the FFT, or can be specified as a value expressed in number of sampled data points or in milliseconds. Frame advance is independent of frame length, so the analysis results can be for contiguous or overlapping frames, or can provide a small sample of FFT information for the data.
- **Frame Length** - Specifies the length of each frame of data to be analyzed. Frame length can be equal to the number of FFT coefficients (FFT Analysis Size), can be delineated by voiced period marks in the sampled data (Pitch-Synchronous), or can be another value expressed in number of sampled data points or in milliseconds. The frame length cannot be greater than the FFT analysis size. If the selected frame length is less than the FFT analysis size, the frame is padded with zeros.

FFTW Options: Display Tab

From the Display Tab, set the following FFTW options:

- **Display Range (X-Axis)** - Specifies the frequency range (x-axis) over which the power spectra are displayed. The frequency range can be displayed as a percentage of the Nyquist Frequency or as specific upper and lower frequency values.
- **Display Range (Y-Axis)** - Controls the display range along the y-axis, in decibels of sound pressure (dB SPL).
- **Skew Angle** - Specifies the angle of the waterfall display to skew to the left or to the right. The window is divided into four quadrants of equal size. When set to skew right, the start frame is drawn in the bottom left quadrant and subsequent frames are drawn behind it and angled up and to the right. When set to skew left, the start frame is drawn in the bottom right quadrant and subsequent frames are drawn behind it and angled up and to the left.
- **Start Frame** - Specifies whether the first or last frame of the analysis results is plotted at the front of the waterfall array. Frames are plotted consecutively on the z-axis from first to last or from last to first, with the start frame plotted in the lower left or right quadrant of the window, depending on the setting for Skew Angle.

The CSL Main Program and Multi-Speech allows you to generate a series of discrete power spectra using the Fast Fourier Transform (FFT) algorithm, taking frames of waveform data in a specified range in the source window, and displaying the resulting power spectra in a waterfall array in the active window.

To create an FFT Waterfall Display:

1. Ensure that a waveform is displayed in the source window. The active window must be empty prior to command execution.
2. If voiced period marks (impulse marks) are present in the waveform data, you can perform pitch-synchronous analysis. In this case, the data between two voiced period marks are used for analysis. Otherwise, frames of data of a fixed length are used.

3. Before generating the FFT waterfall display, set the FFTW analysis parameters. To do this, select **Analysis, FFT Waterfall** from the **Options** menu to display a box in which you can view and change these parameters.
4. To generate the waterfall display, choose **FFT Waterfall** from the **Analysis** menu. A submenu appears in the work area giving you the option to generate the FFT waterfall display from all the source data (**All Data**), a selected region of the source data (**Selected Data**), or the displayed data (**Displayed Data**). Select the range of data you want to analyze.
5. During the analysis, a dialog box appears in the work area, telling you which frame is being processed and the total number of frames that will be processed, and giving you the option to Stop Processing.
6. The FFT Waterfall display for the specified range is drawn in the active window, and the first frame of the analysis results is highlighted. Depending on the setting for FFTW Start Frame, this first frame can be plotted at the front or back of the array. The values in the x-axis, y-axis, and z-axis boxes on the window status line report the frequency (Hz), energy (dB), and time (sec) values at the data cursor in the highlighted frame. Use the [Up] arrow key to scroll forward in time on the z-axis, highlighting each power spectrum (from first to last) in turn, and use the [Down] arrow key to scroll backward in time on the z-axis. Alternatively, click the mouse on the z-axis (time axis) to highlight a specific frame.
7. The output of the FFT Waterfall analysis is not supported by numerical results or result statistics.

5-5 LTA Power Spectrum

From the **Options** menu, select **Analysis**, then **LTA Power Spectrum**. You can set the following LTA Analysis options:

- **Analysis Size** - Specifies the length of the frame of data to be analyzed, in number of sampled data points.
- **Display Range (X-Axis)** - Specifies the frequency range (X-Axis) over which the power spectrum will be displayed. You can choose to display the frequency range as a percentage of the Nyquist Frequency or as specific upper and lower frequency values.
- **Display Range (Y-Axis)** - Controls the display range setting along the Y-axis, in decibels of sound pressure (dB SPL). If normalization is on, this parameter is ignored.
- **Pre-Emphasis** - Determines the application of pre-emphasis and the value of the pre-emphasis factor. A value of 0 means no pre-emphasis is applied.
- **Smoothing** - The power spectrum can be displayed in BLOCK mode or POINT mode, with a smoothing factor optionally applied to the spectral coefficients in point mode. Smoothing the energy in values in the frequency domain of the power spectrum is done in order to suppress the harmonic ripple present in the signal. The degree of smoothing to be applied depends upon the harmonic separation in the signal and upon the frequency resolution of the LTA power spectrum.
- **Window Weighting** - Controls the application of window weighting to a frame of sampled data that is to be processed. Window weighting is applied to reduce the amplitude of the signal as it approaches a frame boundary. If a rectangular window is selected, its effect is to apply no window weighting. A Blackman or Hamming window is recommended for speech processing.

To create an LTA Power Spectrum:

1. Ensure that a waveform is displayed in the source window. The active window must either be empty or contain frequency response (FFT or LPC) data.
2. Before generating the LTA power spectrum, set up the LTA analysis parameters. This can be done by selecting **Analysis**, **LTA Power Spectrum** from the **Options** menu to display a box in which you can view and change these parameters.
3. To generate the LTA power spectrum, choose **LTA Power Spectrum** from the **Analysis** menu. A submenu appears in the work area giving you the option to generate the LTA power spectrum on all the source data (**All Data**), a selected region of the source data (**Selected Data**), or the displayed data (**Displayed Data**). Select the range of data you want to analyze.
4. During the analysis, a dialog box appears in the work area, telling you which frame is being processed and the total number of frames that will be processed, and giving you the option to Stop Processing.
5. The LTA power spectrum for the specified range is drawn in the active window, and the range of data used to produce the LTA power spectrum is highlighted in the source window. Numerical results and result statistics can now be displayed, and optionally printed and saved, or copied to the clipboard then pasted into a spreadsheet.

5-6 Cepstrum Analysis

From the Options menu, select Analysis, then Cepstrum Analysis. You can set the following Cepstrum options:

- **Time** sets the time domain of the quefrency axis (X-Axis) over which the cepstrum will be displayed. The time display range is in milliseconds. Select the Display All Data checkbox to display all of the data, or clear the checkbox and enter values in the Minimum and Maximum edit boxes to display a smaller specified range. Recommended time values are 0.1 and 12.0. When normalization is applied to this display, it is normalized to the maximum and minimum values found within this range.
- **Level** sets the amplitude display range (Y-Axis) for the cepstrum display. If normalization is turned on, the parameter is ignored.

You can generate an inverse spectrum from a power spectrum that was previously generated with either the **FFT** or **LTA** command, taking spectral data from a specified window and displaying the results on a time (quefrency) axis in the active window.

The inverse spectrum is generated by taking an FFT of the log magnitude values of a power spectrum. The purpose of the inverse spectrum is to isolate the harmonic energy that is present in a spectrum of voiced speech, which can be used to determine the fundamental frequency of the voiced signal.

The fundamental frequency can be determined by taking the inverse of the time location associated with the highest magnitude peak at a time location that is greater than about 4 msec (i.e., a fundamental frequency that is less than 250 Hz). The magnitude of this fundamental peak is directly related to the accumulation of harmonic energy in the power spectrum. Other peaks, referred to as “rahmonics”, often appear at higher time locations and appear to be related to the strength of side lobes in the power spectrum.

The examination of the characteristics of the quefrency peaks is also useful to determine the degree of periodicity of voiced speech. If the signal is predominantly periodic, the peak is dominant; if the signal is aperiodic, then the peak is weak relative to the other energy in the spectrum.

To create an Inverse Spectrum

1. Ensure that a waveform is displayed in the source window. Window B must be the active window and must be empty or contain frequency response (FFT or LPC) data. Window C must be open and empty.
2. Generate a power spectrum using the FFT or LTA analysis routine, placing the data in Window B.

   Before creating the power spectrum, ensure that you are performing an asynchronous (or fixed frame) analysis and that the frame length is set to a length of at least two pitch periods, so that the harmonic ripple is clearly displayed in the spectrum. In practice, a 1024 point FFT is used for data sampled at rates between 20K to 25.6K per second, representing a frame duration of 40 to 50 msec. A 512 point FFT can be applied to lower sampled data rates. You can find out the sampling rate of the data by selecting **Information on Active Window** from the **Window** menu.
3. Before generating the inverse spectrum, set the Cepstral analysis parameters.
4. Activate Window C to display the inverse spectrum. This window must be empty.
5. To create an inverse spectrum of the power spectrum in Window B, choose **Cepstrum Analysis, Cepstrum of FFT in Window B** from the **Analysis** menu. The inverse spectrum is displayed in Window C.
6. Numerical results and result statistics can now be displayed, and optionally printed and saved, or copied to the clipboard then pasted into a spreadsheet.
7. You can also create a smoothed spectrum from the first 3 msec. of the cepstrum in Window C from the **Analysis** menu. by selecting **Cepstrum Analysis, FFT of Cepstrum in Window** C. The results are drawn in Window B.

5-7 Spectrogram

From the Options menu, select Analysis, then Spectrogram. There are a number of Spectrogram analysis and display parameters that can be set by the user. The Spectrogram Analysis Configuration box contains three (3) separate tabs. Click on the appropriate tab for the options you want to set, and then set the desired parameters.

SPG Options: Analysis Tab

From the Analysis tab, you can set the following Spectrogram Options:

- **Analysis Size** - Specifies the number of sampled data points per frame that are to be applied to the spectrogram. The number of data points translates to a spectrogram "bandwidth," which is interpreted by the CSL Main Program and Multi-Speech from the frame length and the sampling rate of the data in the source window.
- If the source window contains signal data, a Hertz value is reported in the **Analysis Size** box beside each points value, along with a message that the displayed bandwidths are for analysis of the current default source.
- **Pre-Emphasis** - Determines the application of pre-emphasis and the value of the pre-emphasis factor. A value of 0 means no pre-emphasis is applied.

- **Window Weighting** - Controls the application of window weighting to a frame of sampled data that is to be processed during SPG analysis. Window weighting is applied to reduce the amplitude of the signal as it approaches a frame boundary. If a rectangular window is selected, its effect is to apply no window weighting. A Blackman or Hamming window is recommended for speech processing.

SPG Options: Display Tab

From the Display tab, you can set the following Spectrogram Options:

- **Display** - Specifies the frequency range over which the spectrogram will be displayed. You can choose to display the frequency range as a percentage of the Nyquist Frequency or as specific upper and lower frequency values. The recommended maximum frequency is 40% of the sampling rate.
- **Frequency Display** - Specifies whether the display of the spectrogram will be shown in a logarithmic scale, linear scale, Bark scale or Mel scale.

SPG Options: Palette Tab

From the Palette tab, you can set the following Spectrogram Options:

- **Palette** - Selects one of the preset color palettes to be used to display the spectrogram.
- **Scale** - Displays the decibel range assigned to evenly distributed gray shades or colors used to plot the relative levels of energy in the spectrogram. You can change any of these values. Alternatively, enter a minimum and maximum decibel level, and click the **Smooth** button (to the right) to create a linear relationship to the values assigned to the interceding shades. Use the scrollbar to raise or lower the overall color scale-to-gain assignment, to brighten or darken the display.
- **Scale Adjustment** - Specifies an adjustment in decibels of sound pressure (dB SPL) that is applied to the color scale of the spectrogram, to lighten or darken the color scale.

In this section you will generate an FFT-based three-dimensional spectrogram.

A power spectrum is computed for a series of frames of sampled data in the specified range. Each computed spectrum is displayed as a single vertical column, with frequency on the vertical axis and energy expressed in darkness or color gradients. Time is represented on the horizontal axis, and is represented by one spectrum of a frame of sample data for each pixel column in the window.

To create a Spectrogram:

1. Ensure that a waveform is displayed in the source window. The active window must be empty.
2. Before generating the spectrogram, configure the SPG analysis parameters. Select **Analysis**, **Spectrogram** and **All Data**, **Selected Data**, or **Displayed Data** from the **Options** menu to display a box to can view and change these settings.
3. During the analysis, a dialog box appears in the work area, displaying the number of the frame being processed and the total number of frames. You can abort the analysis by clicking the **Stop Processing** box, or pressing the Enter key before analysis is complete.

Note: The spectrogram for the specified range is drawn in the active window, and the sampled data that contributes to the spectrogram frame at the cursor location is highlighted in the source waveform. The output of the spectrographic analysis is not supported by numerical results and result statistics. You can overlay any time domain analysis data onto a spectrogram

5-8 Formant History Analysis

From the **Options** menu, select **Analysis**, then **Formant History**. There are a number of FMT analysis and display parameters that can be set by the user. Note that the Formant Analysis Configuration box contains four (4) separate tabs. Click on the appropriate tab for the options you want to set, and then set the desired parameters.

FMT Options: Analysis Tab

From the Analysis Tab, set the following FMT options:

- **Filter Order** - Selects the filter order, or the number of LPC coefficients, to be applied to each LPC analysis frame.
- **Pre-Emphasis** - Determines the application of pre-emphasis and the value of the pre-emphasis factor. A value of 0 means that no pre-emphasis is applied.
- **Analysis Method** - Selects the LPC analysis method. You have a choice of the autocorrelation or covariance methods.
- **Window Weighting** - Controls the application of window weighting to a frame of sampled data that is to be processed during FMT analysis. Window weighting is applied to reduce the amplitude of the signal as it approaches a frame boundary. If a rectangular window is selected, its effect is to apply no window weighting. Window weighting is recommended when using the autocorrelation method, and the rectangular window is recommended when the covariance method is applied.

FMT Options: Framing Tab

From the Framing Tab, set the following FMT options:

- **Pitch-Synchronous (Use Voiced Period Marks)** - Selects calculation of formant history framing from voiced period marks that are present in the data or from a fixed frame length.
- **Unvoiced Frame Size** - Specifies the length of the frame of data to be analyzed when performing fixed frame analysis. During pitch-synchronous analysis, this variable is used for data in voiceless regions only, and the voiced regions are analyzed using a frame length determined by the voiced period marks.
- **Frame Advance** - Selects the time, in milliseconds, by which the analysis frame is advanced during fixed frame analysis. Frame advance is independent of the frame length, so the FMT analysis results can be for contiguous or overlapping frames, or can provide a small sample of FMT information for the data. This option is disabled during pitch-synchronous analysis (i.e., **Use Voiced Period Marks** is selected).

FMT Options: Display Tab

From the Display Tab, set the following FMT options:

- **Display Range** - Specifies the frequency range over which the formant history will be displayed. You can choose to display the frequency range as a percentage of the Nyquist Frequency or as specific upper and lower frequency values.
- **Bandwidth Limit** - Specifies whether to display all formants, or whether to set a threshold value of the bandwidth, so that formants above the threshold are not included in the graphic display, and are optionally excluded from the reported numerical results.

- **Energy Limit** - Specifies whether to display all formants, or whether to turn off LPC analysis in frames whose signal energy is less than the set threshold value, so that formants in analysis frames with energy below the set threshold are not included in the graphic display, and are optionally excluded from the reported numerical results.
- **Only Voiced** - Specifies whether to display all formants, or whether to turn off LPC analysis in frames that are voiceless.
- **Show Bandwidth** - Specifies whether to display the bandwidth with each reported formant frequency so that the length of the vertical line represents the bandwidth of the formant, or whether to display the formant contours as a series of dots.
- **Frequency Display** - Specifies whether the display of the formant history will be shown in a logarithmic scale, linear scale, Bark scale, or Mel scale.

FMT Options: Color Tab

From the Color Tab, set the following FMT options:

- **Use Large Dots** - Specify whether to display the formant history plot using large dots or small dots.
- **Contour Colors** - Specify the colors to display the formant contours. For improved observation and editing purposes, a different color can be assigned to each formant. Alternatively, all formants can be displayed using the window pen color.

The CSL Main Program and Multi-Speech allow you to generate an LPC-based time history formant display of a range of data in the source window, displaying the resulting formants over time in the active window.

To create a Time History Formant display:

1. Ensure that a waveform is displayed in the source window. The active window must be empty or contain a time series of analysis data.
2. Before generating the formant history, set the FMT analysis parameters. Do this at the **Options** menu under **Analysis**, **Formant History** and **All Data**, **Selected Data ,** or **Displayed Data**.
3. Choose **Formant History** from the **Analysis** menu. A submenu appears in the work area giving you a list of analysis range options to create the formant history from. Select **All Data** to analyze all the source data, **Selected Data** to produce a spectrogram of only the selected region of the source data, **Displayed Data** for the displayed data, and **1st Sec. of Displayed** or **1st 2 Secs. of Displayed** to use only the first one or two seconds of the displayed data.
4. The corresponding formant history for the specified range is drawn in the active window. Numerical results and result statistics can now be displayed, and optionally printed and saved, or copied to the clipboard then pasted into a spreadsheet.

5-9 Voiced Period Marks (Impulse) Options

From the **Options** menu, select **Analysis**, then **Voiced Period Marks**. You can set the following Impulse Analysis Options:

- **Analysis Range** - Specifies the analysis range setting in Hertz. A narrower range can be set to selectively examine a particular region of the signal, while a wide analysis range (for example, 50 to 1000 Hz) can be used successfully for most speech. Reducing the range can help to avoid erroneous selection of harmonic periods in low-frequency signals.
- **Location** - Governs the location where the voiced period marks are placed during analysis. If Peak is selected, impulse marks are placed at the dominant amplitude peak at the start of each voiced period. This could be a negative or a positive peak depending upon the polarity of the signal. If Zero Crossing is selected, impulse marks are placed at the zero crossing immediately preceding the dominant amplitude peak at the start of each voiced period.
- **Zero Offset** - Specifies the zero offset in amplitude to compensate for any DC float that can have been produced by the hardware. If the signal offset has been previously computed, the resulting value is automatically used.

You can compute the periodicity of voiced speech in the active window and mark the waveform data at time locations to separate the voiced periods. These marks are referred to as **voiced period marks**, or **impulse marks**. The process separates the voiced signal into its periodic components, the inverse of each period being the fundamental frequency, or pitch separation, of the signal as it changes over time.

Note Voiced period marks must be inserted in the waveform data before pitch-synchronous analysis can be performed on the sampled data.

To display and hide voiced period (impulse marks

Voiced period marks can be present in the waveform but hidden from view unless the settings are configured to display them. To turn display of voiced period or impulse marks on and off:

1. To display the marks in the active window, select **Waveform** from the **Options** menu to display a dialog box in which you can set the signal attributes to display. Enable the **Impulse Marks** checkbox, causing a check mark to appear in the check box.
2. Remove the voiced period marks from the window without deleting them from the waveform data by clearing the **Impulse Marks** checkbox in the Signal Display Options dialog box.

5-10 Pitch Contour Analysis

From the **Options** menu, select **Analysis**, then **Pitch Contour**. There are a number of Pitch analysis and display parameters that can be set by the user. The Pitch Analysis box contains three (3) separate tabs. Click on the appropriate tab for the options you want to set, and then set the desired parameters.

Pitch Options: Analysis Tab

From the Analysis tab, you can set the following Pitch Options:

- **Pitch Synchronous Analysis** - Specifies pitch synchronous (from impulse marks) or pitch asynchronous (i.e., fixed frame) analysis. If this checkbox is selected and impulse marks are not in the signal data, the pitch synchronous analysis process will compute impulse locations and store them internally. If this checkbox is selected and impulse marks are in the signal, then the impulse locations in the signal are used. If this checkbox is clear (unselected), fixed frame analysis is performed using the frame length and frame advance settings specified on the Framing tab. Interpolation is applied to the pitch analysis results (pitch synchronous or fixed frame) in order to improve the resolution of the pitch analysis process.
- **Impulse Location** – Specifies the location of the impulse marks computed during pitch synchronous analysis. Options are at the dominant amplitude peak (which can be negative or positive, depending on the polarity of the signal) at the start of each voiced period, or at the zero crossing immediately preceding the dominant amplitude peak at the start of each voiced period. Note that this option is disabled if the **Pitch Synchronous Analysis** checkbox is clear (unselected). If Pitch Synchronous Analysis is selected and impulse marks are already in the signal, this setting is ignored.
- **Analysis Range** - Specifies the analysis range setting in frequency (Hertz) for accepting fundamental frequency (pitch) analysis results. To avoid possible error, the analysis range should be close to the expected fundamental frequency range.
- **Process High Frequency Signal** – Specifies analysis of a high-frequency signal. Use this setting to obtain better results when analyzing some signals from a female or child's voice. Note that this option is disabled if the **Pitch Synchronous Analysis** checkbox is selected.
- **Pitch Sensitivity** – Specifies the sensitivity of the pitch analysis routine. If the pitch analysis does not produce pitch values in expected locations (giving drop-outs in the analysis), increase the pitch sensitivity. If the pitch analysis is detecting more pitch values than expected (giving spurious values in the analysis), decrease the pitch sensitivity. Note that this option is disabled if the **Pitch Synchronous Analysis** checkbox is selected.
- **Smoothing Level** - Optionally smooths the pitch contour by replacing the un-smoothed pitch results with new values that are computed by applying median smoothing to the voiced frames that are located within a specified time interval that is centered around the start of the current frame. The duration of the time interval is 50 msec if a **Low** level of smoothing is selected, 100 msec for **Medium**, and 200 msec for **High**. The number of adjacent frames that is used to smooth each frame consists of all frames that lie completely within the time interval that corresponds to the smoothing level selected. Select **None** to display the un-smoothed pitch results. Note that the **Low** radio button is disabled if either the Frame Length or Frame Advance setting is greater than 25 msec.

Pitch Options: Framing Tab

From the Framing tab, you can set the following Pitch Options:

- **Frame Length** - During fixed frame (or pitch-asynchronous) analysis, specifies the length of a frame of waveform data used for computing the fundamental frequency (pitch). Note that this option is disabled if the **Pitch Synchronous Analysis** checkbox is selected on the Analysis tab.
- **Frame Advance** - Selects the time, in milliseconds, by which the analysis frame is advanced during fixed frame analysis. Frame advance is independent of frame length, so the pitch analysis results can be for contiguous or overlapping frames, or can provide a small sample of pitch information for the data. The smaller the frame advance is, the more detail about the pitch characteristics becomes available. Note that this option is disabled if the **Pitch Synchronous Analysis** checkbox is selected on the Analysis tab.

Pitch Options: Display Tab

From the Display tab, you can set the following Pitch Options:

- **Display Range** - Specifies the display range in frequency (Hertz) for the display of a pitch contour. Note that the display range is set separately for pitch contours displayed on a logarithmic frequency scale or a linear frequency scale. If normalization is on, this parameter is ignored.
- **Draw Dot Contour** - Selects display of the pitch plot as a series of dots or as a solid line.
- **Use Large Dots** - If a dot contour display is selected, specifies whether to display the pitch contour using large dots or small dots.
- **Frequency Scale** - Selects display of the pitch contour on a logarithmic or linear frequency scale.

The CSL Main Program and Multi-Speech allows you to compute the fundamental frequency (pitch) of a range of voiced data in the source window and display the resulting pitch contour in the active window.

To create a pitch contour:

1. Ensure that a waveform is displayed in the source window. The active window must be empty or contain time domain analysis data prior to command execution.
2. Before generating the pitch contour, set up the pitch analysis parameters. This can be done by selecting **Analysis**, **Pitch Contour** from the **Options** menu to display a box in which you can view and change these parameters.
3. If pitch-synchronous analysis is performed, the fundamental frequency values are extracted by computing the inverse of the time between each voiced period mark (impulse mark) in the data. If impulse marks are not in the signal when pitch-synchronous analysis is performed, the pitch synchronous analysis process will compute the impulse locations and store them internally. If impulse marks are in the signal, then the impulse locations in the signal are used.
4. If pitch-asynchronous (fixed frame) analysis is performed, the fundamental frequency is extracted directly from the waveform by determining the time intervals between dominant peaks in the waveform. The waveform is first broken into regular intervals (frames), the duration of which is set by the user. Note that frame length must be set to at least two pitch periods to achieve good results.
5. Interpolation is applied to the pitch analysis results (pitch synchronous or fixed frame) in order to improve the resolution of the pitch analysis process.

6. To generate a pitch contour, select **Pitch Contour** from the **Analysis** menu. A submenu appears in the work area giving you the option to create a pitch contour on all the data (**All Data**), the selected region of the data (**Selected Data**), or the currently displayed data (**Displayed Data**).
7. The resulting pitch contour is drawn in the active window. Numerical results and result statistics can now be displayed, and optionally printed and saved, or copied to the clipboard then pasted into a spreadsheet.

5-11 Energy Contour Analysis

From the **Options** menu, select **Analysis**, then **Energy Contour**. You can set the following Energy Options:

- **Frame Length** - Specifies the length of a frame of a data used for energy calculation. This parameter specifies the frame length in voiceless regions only if pitch-synchronous analysis is used.
- **Frame Advance** - Selects the time, in milliseconds, by which the analysis frame is advanced. Frame advance is independent of the frame length, so the energy analysis results can be for contiguous or overlapping frames, or can provide a small sample of energy information for the data. This parameter is ignored during pitch-synchronous analysis.
- **Pitch-Synchronous** - Selects calculation of energy frames from voiced period marks that are present in the data (pitch-synchronous) or from a set frame length.
- **Draw Dot Contour** - Selects display of the energy plot as a series of dots or as a solid line.
- **Use Large Dots** – If a dot contour display is selected, specifies whether to display the energy contour using large dots or small dots.
- **Smoothing Level** - You can optionally apply smoothing to the computed energy values across adjacent frames.
- **Display Range** - Specifies the display range in decibels of sound pressure (dB SPL) for the display of the energy contour. If normalization is on, this parameter is ignored. Note that the display range is automatically adjusted by the energy shift value if the **Energy Shift** checkbox is selected.
- **Energy Shift** - Specifies whether to shift the calculated energy values by a set shift value, to adjust the dB values to approximate real-world dB SPL. If the **Energy Shift** checkbox is selected, the shift value can be entered in the associated edit box.

You can compute the energy of a range of waveform data in the source window and display the resulting energy contour in the active window.

The energy operation calculates the sum of the absolute amplitude values in a frame of data divided by the number of points in the frame. The energy is first computed and then converted to decibels of sound pressure (dB SPL).

To create an energy contour:

1. Ensure that a waveform is displayed in the source window. The active window must be empty or contain a time series of analysis data.
2. Before generating an energy contour, set the energy analysis parameters. This can be done by selecting **Analysis**, **Energy Contour** from the **Options** menu to display a box in which you can view and change these parameters.
3. To create an energy contour, select **Energy Contour** from the **Analysis** menu. A submenu appears in the work area giving you the option to create an energy contour on all the data by selecting **All Data**, on the selected region of data by selecting **Selected Data,** or on the currently displayed data by selecting **Displayed Data**.
4. The resulting energy contour is drawn in the active window. Numerical results and result statistics can now be displayed, and optionally printed and saved, or copied to the clipboard then pasted into a spreadsheet.

5-12 Compute, Save, and Print Result Statistics

The CSL Main Program and Multi-Speech can display, save, and print, and save a series of statistical analyses that are derived from the most recently computed analysis results in the active window. Statistics and other text data can be copied and pasted to other applications.

To produce result statistics:

1. Ensure that the window contains analysis data. Note that result statistics are not available for transient data.
2. Several windows containing analysis data can be displayed in the work area at once, and each of these windows can contain the results of more than one analysis.
3. To display the result statistics for the topmost analysis data in the active window, select **Compute Result Statistics** from the **Analysis** menu.

A dialog box appears in the work area displaying the result statistics.

4. At the Result Statistics dialog box, you can print the results and to save them in a file. You can also click on the **Info** button to display a second box containing the summary information and any textual information that has been entered into the comment field.
5. Remove the Result Statistics dialog box by clicking the **Done** button.

To save result statistics as a text file:

1. With the statistics displayed, click the **Save As** button in the Result Statistics box. A Save Results box is displayed in the work area. The type of analysis is displayed at the top of the box (i.e., Pitch, LPC, etc.).
2. Select the correct drive and directory location, and enter a file name in the **File Name** box. The fine will save with the default *.txt extension.
3. Choose how the columns of information will be separated when the result file is saved to disk storage. The field separator can be a space, a tab, or a comma. Choose the **Tab** or **Comma** option to format the file for access by a spreadsheet program. Select the **Space** option to save the file so that the display is easily read when you send it to the printer or if you intend to edit it at a later date using any standard text editor.

4. In the Contents section, select the information you wish to save in the file. This can include parameter information, statistics, and numerical results. When saving LPC results, you can save the frequency response and/or the formants information. When saving FMT results, you can save all formant/bandwidth values, or can limit the file to formants above a specified bandwidth value.
5. Once you have selected the information you wish to save and the column separator, click the **Save** button to save the data to a results file. Click the **Cancel** button to close the Save Results box without saving the data.

To print result statistics

1. With the result statistics displayed, click the **Print** button in the Result Statistics box. A Print Results box is displayed in the work area. The type of analysis is displayed at the top of the box (i.e., Pitch, LPC, etc.).
2. In the Margins section, you can enter header and/or footer information, including text, the current time (%t), current date (%d), and page numbers (%p). The format is left;center;right.
3. In the Contents section, select the information you wish to print. This can include parameter information, statistics, and numerical results. When printing LPC results, you can print the frequency response and/or the formants information. When printing FMT results, you can print all formant/bandwidth values, or can limit the printout to formants above a specified bandwidth value.
4. Click the **Setup** button to select the default printer and access other printing options for the selected printer. Click the **Fonts** button to select the font to use, font size, etc.
5. Once you have selected the information you wish to print (including any header or footer), click the **Print** button in the Print Results box. Click **Done** to close the Print Results box without printing any information.

To copy result statistics to the clipboard

1. Click the **Copy to Clipboard** button to copy all result statistics to the clipboard. The data can then be pasted into a spreadsheet or other application from the clipboard.
2. Note that the Formant Result Statistics are displayed across several pages. In this case, only the statistics on the displayed page are copied when **Copy to Clipboard** is selected.

5-13 Produce, Save, and Print Numerical Results

You can display, and optionally print and save, the numerical results associated with the topmost analysis data in a specified window. You can also copy selected numerical results to the clipboard, then paste from the clipboard to a spreadsheet or other application.

To display numerical results:

1. Ensure that analysis results data are displayed in a window. Note that numerical results are not available for transient data.
2. Several windows containing analysis data can be displayed in the work area at once, and each of these windows can contain the results of more than one analysis.
3. To display numerical results for the topmost analysis data in the active window, select **Produce Numerical Results** from the **Analysis** menu.

4. A dialog box appears in the work area displaying the numerical results.
5. You have the option of saving the results in a file or sending the results to a printer. You can also click on the **Info** button to display a second box containing the summary information and any textual information entered into the comment field.
6. Remove the numerical results box by clicking the **Done** button.

To save numerical results

1. With the numerical results displayed, click the **Save As** button in the Analysis Results box. A Save Results box is displayed in the work area. The type of analysis is displayed at the top of the box (i.e., Pitch, LPC, etc.).
2. Select the correct drive and directory location, and enter a file name in the **File Name** box. Unless a different file extension is specified as part of the file name, a .TXT file extension is appended to the file name, to identify the type of file.
3. Choose how the columns of information will be separated when the result file is saved to disk storage. The field separator can be a space, a tab, or a comma. Choose the **Tab** or **Comma** option to format the file for access by a spreadsheet program. Select the **Space** option to save the file so that the display is easily read when you send it to the printer, or if you intend to edit it at a later date using any standard text editor.
1. In the Contents section, select the information you wish to save in the file. This can include parameter information, statistics, and numerical results. When saving LPC results, you can save the frequency response and/or the formants information. When saving FMT results, you can save all formant/bandwidth values, or can limit the file to formants above a specified bandwidth value.
2. Once you have selected the information you wish to save and the column separator, click the **OK** button to save the data to a results file. Click the **Cancel** button to close the Save Results box without saving the data.

To print numerical results

1. With the numerical results displayed, click the **Print** button in the Analysis Results box. A Print Results box is displayed in the work area. The type of analysis is displayed at the top of the box (i.e., pitch, LPC, etc.).
2. In the Margins section, you can enter header and/or footer information, including text, the current time (%t), current date (%d), and page numbers (%p). The format is left;center;right.
3. In the Contents section, select the information you wish to print. This can include parameter information, statistics, and numerical results. When printing LPC results, you can print the frequency response and/or the formants information. When printing FMT results, you can print all formant/bandwidth values, or can limit the printout to formants above a specified bandwidth value.
4. Click the **Setup** button to select the default printer and access other printing options for the selected printer. Click the **Fonts** button to select the font to use, font size, etc.
5. Once you have selected the information you wish to print (including any header or footer), click the **Print** button in the Print Results box. Click **Done** to close the Print Results box without printing any information.

To copy numerical results to clipboard

1. Optionally click anywhere inside the numerical results list box and press the [Ctrl+A] keys to select all data, then press [Ctrl+C] to copy the numerical results to the clipboard.
2. Alternatively, select one or more columns of results data, then press the [Ctrl+C] keys to copy the selected columns of data.
3. You can also select individual cells of data by holding down the [Ctrl] key as you click on the data items, or select a block of data by clicking in a cell (e.g., top left corner of the block to be selected), then holding down the [Shift] key and clicking another cell (e.g., bottom right corner of block) in the list box. Cells are highlighted when selected.
4. At any time, press [Ctrl+U] to unselect all cells, and then optionally select a different range.
5. After selecting the desired data, press [Ctrl+C] to copy them to the clipboard. The copied data can then be pasted into a spreadsheet or other application from the clipboard.
6. Note that column headings are not included with the data when they are copied and pasted.

6 Data Operations

This section covers basic files operations including loading, saving, importing and exporting data, and taking screenshots of your work.

6-1 Opening a Saved or Demo File

Click within the window you want to open the file in

1. At the **File** menu, select **Open (Load)** and navigate to the desire file.
   - To open headerless files, type "*.*) in the search field to view files of all types.
2. Click OK to open the file. If the window contains previous data, you will be prompted to confirm you wish to purge that data. Click **Yes** if you want to purge and replace or **No** if you do not.
   - If in step 3 you chose not to purge existing data, at the Window menu, select, Open New Window and repeat from step 1.

6-2 Saving Waveform Data

To save your work to a file:

1. At the **File** menu, select **Save**.
   - To open headerless files, type "*.*) in the search field to view files of all types.
2. Click OK to open the file. If the window contains previous data, you will be prompted to confirm you wish to purge that data. Click **Yes** if you want to purge and replace or **No** if you do not.
   - If in step 3 you chose not to purge existing data, at the Window menu, select, Open New Window and repeat from step 1.
3. In most cases, you will wish to save to the NSP file format. Select the desired folder, and press a "MU-LAW" folder which contains folders named "10000", "11025", **Save**

   A new file with the name and format specified will be stored to your computer.

Note: In the native NSP format, waveform data is stored along with features such as IPA characters, impulse marks, palatogram information, text in comments will save if saved in the file. RAW and WAV and headerless files contain only audio.

To save the waveform data in the active window:

1. From the **File** menu, choose **Save**.
2. A progress meter is then displayed, showing the progress of the file-saving operation.

6-3 Using Configuration Files

A default program initialization file is included with the delivery. This factory default file is never altered by the program. When you run the program, a temporary user file is created which stores all work area layout and parameter setting changes made. You have the option of saving these changes to a permanent user configuration file or to another configuration file.

You can also activate other configuration files. Note that all parameter setting changes you make are saved in a temporary file until specifically written to the active initialization file, identified in a box on the application status line. Thus, you can discard the changes when the session ends, so that each session starts from the same configuration.

Each time a command is executed, the program searches for any required parameter settings first in the temporary copy of the active configuration file, which is identified on the status line. This temporary file contains any changes that have been made to the work area layout and parameter settings. If the required settings are not found, the program next looks in the user configuration file, if it exists, then finally in the factory-delivered default configuration file.

Activating Configuration Files

When you reset the program, existing windows are deleted and all data are lost. Before executing any of these commands, you should save any data that you want available at a later time to disk storage.

1. At any time, you can reset the program to the default (factory delivered) configuration by selecting **Configuration Files, Reset User Configuration to Factory Settings** from the **File** menu. This will delete both the permanent and temporary copies of the user configuration file, if it exists, before redrawing the work area with the default layout. A new temporary file is created to store all parameter changes made, which can be written to a permanent user configuration file.
2. You can reset the program to the work area layout and parameter settings defined in the user configuration file, if it exists. Select **Reset (to the User Configuration)** from the **File** menu. The temporary user file is deleted and the user configuration file becomes the active initialization file. A new temporary user file is created to store all parameter changes made, which can be written to a permanent user configuration file.
3. If you have created other configuration files, you can reset the program to any saved configuration by selecting **Configuration Files, Reset to an Alternate Configuration** from the **File** menu. The named configuration file becomes the active file, and the configuration file box on the status line is updated to display the name of this file. Any subsequent changes to the work area layout or parameter settings are written to a temporary copy of this active file until specifically saved.
4. In each case, a warning message is displayed before the program configuration is reset. Click **Yes** to continue with the operation; click **No** to cancel the request to reset.

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Saving Configuration Files

Note that all parameter setting changes you make are saved in a temporary initialization file until specifically written to the active file, which is identified in a box on the status line. Thus, you can discard the changes when the session ends, so that each session starts from the same configuration.

To save the settings in the temporary configuration file:

1. When the program starts, a temporary copy of the active configuration file is created. The active file is usually the user configuration file. When the work area layout or command parameter settings are changed, these changes are written to this temporary file.
2. You have the option of saving changes stored in the temporary user file to the permanent user configuration file. Select **Configuration Files, Save (Update) the User Configuration File** from the **File** menu. The current window layout and parameter settings are copied from the temporary file into the user configuration file. Note that if the user configuration file is not active, an error message is returned.
3. You can create a number of configuration files, each designed to configure the program for a specific task. These configuration files can be used, for example, to define the work area layout and program variables for use in a macro.
4. Save the changes in the temporary file to a configuration file other than the active file by selecting **Configuration Files, Save a New Alternate Configuration File** from **File** menu. A standard file saving box is displayed, allowing entry of the drive, directory location and name for the configuration file. An INI file extension is appended to the filename, to identify the file type. Click **OK** to complete the file save operation. The current window layout and parameter settings are copied from the temporary file into the named configuration file. Note that writing these settings to a different file does not change the active configuration file.

Save the Current Settings

The default program configuration is written to the registry when the program is installed. These factory settings are never altered by the program. When you run the program, all parameter setting changes made in the session are stored in temporary memory. You have the option of saving these changes to a permanent user configuration in the registry.

If you do not save the new settings selected during a session, the changes are discarded when you exit the program. This allows each session to start from the same configuration.

Each time a command is executed, the program first searches for any required parameter settings in the temporary memory store. If the required settings are not found, the program looks next in the user settings, if it exists, then finally in the factory settings.

To save the current settings for use in the future:

1. Select **File** from the Main Menu. Then select **Save (Update) the User Configuration**.
2. The current program settings are saved to a user configuration section. These settings are now available for use in future sessions.

Restore the Factory Settings

At any time, you can reset the program to the default (factory delivered) configuration as follows:

3. Select File from the Main Menu. Then select Reset User Configuration to Factory Settings.
4. The user configuration settings and the session settings held in temporary memory are discarded.

6-3-1 Printout of the Application Window

You can send the current graphics information in the work area to a printer.

To generate a screen dump:

1. From the File menu, select Print/Save Graphic Images, then Print Full Screen Image.
2. A Screen Print dialog box is displayed on the screen. You can add a header to the printout by clicking the Header checkbox, then entering the desired text in the Header box. Similarly, you can add a footer to the printout by clicking the Footer checkbox and entering the desired text in the Footer box.
3. Click the Setup button to access a Print Setup dialog box, where you can specify the printer to use, the page orientation, the paper size and the paper source. Click Font to specify the font to use for the header and/or footer.
4. After entering any desired header or footer information, specifying the font and setting up the printer, click Print to send the graphics to the printer. Click Cancel to abort the operation.

6-3-2 Print High-Resolution Image of Active Window

You can send a high-resolution graphic image of the active window to a printer.

To print the active window:

1. From the File menu, select Print/Save Graphic Images, then Print Active Window Image.
2. A Print Setup box is displayed.
3. Specify the printer, paper size, and page orientation, then click OK to dump a graphic image of the contents of the active window to the printer, or click Cancel to abort the operation.
4. The high-resolution graphic image is centered on the printed page.

6-3-3 Save High-Resolution Image of Active Window

You can save a high-resolution graphic image of the active window to a file. The program supports a number of graphic file formats, including bitmap (.bmp), the Joint Photographic Experts Group (JPEG) format (.jpg); graphics interchange format (.gif), and portable network graphics (.png).

To save an image of the active window:

1. From the File menu, select Print/Save Graphic Images, then Save Active Window Image.
2. A Save Window Image dialog box is displayed on the screen.
3. Access the folder to save the image file in, using the Create New Folder feature if necessary.
4. You can save the graphic in BMP, JPG, GIF, or PNG file format. Select the type of file you wish to save from the Save As Type box.

5. Enter a name in the File Name box.
6. The size of the saved image is reported at the bottom of the dialog box, in pixels, inches, or centimeters (cm). Optionally adjust the size of the graphic by modifying the Height and/or Width values. Note that these values are constrained to stay in their original proportion to one another. If you adjust the height of the image, the width changes in relation to the original aspect ratio, and vice versa. Alternatively, when the image size is reported in inches or centimeters, adjust the size of the saved file by increasing or decreasing the dots per inch (DPI) resolution. A smaller resolution produces a smaller graphic image, and a larger resolution produces a larger graphic image.
7. Click the Save button to save the file. Select Cancel to exit the file saving routine without saving the file.
8. A confirmation box is displayed, asking "Do you really want to exit?"
9. Select **Yes** to exit the program, or select **No** to return to normal program operations.

6-4 Source Data

6-4-1 Undo Last Edit in Active Window

To undo the last edit made:

1. At the **Edit** menu, choose **Undo Last Edit in Active**.
2. Repeat as necessary to reverse prior edits. The number of actions you can Undo is limited only by the memory available to the application.

Note: If there is no waveform data or no edits have been performed within the active window, the Undo function will have no effect

6-4-2 Copy Source to Active

You can copy waveform data from the source window to an empty active window.

To copy sampled data:

1. Ensure that a waveform is displayed in the source window. The active window must be empty prior to command execution.
2. At the **Options** menu, select **Editing**, **Copy** to display a box containing the current settings, and adjust the settings as needed to copy what you want.
3. At the **Edit** menu, choose **Copy Source to Active**.
   - To copy everything in the source window, select **All Data**.
   - To copy only a selected region, choose **Selected Data**.
   - To copy only the displayed (visible) data, choose **Displayed Data**.

The specified range of source data is then copied into the active window and displayed there.

6-4-3 Append Source to Active

You can append a range of waveform data from the source window to the end of the waveform data in the active window.

To append sampled data:

1. Ensure that a waveform is displayed in the source window. The active window must contain waveform data with the same sampling rate as the source.

   Before you begin, you can want to check the various setup parameters for this operation. From the **Options** menu, select **Editing**, then select **Append** from the displayed submenu to display a box in which you can select the data appending features.
2. From the **Edit** menu, choose **Append Source to Active**. You now have the option of appending **All Data** in the source, or the **Selected Data**, or **Displayed Data**.

The specified range of source data is then copied into the active window and displayed there.

6-4-4 Multi-Channel Data

If the source waveform contains multi-channel data and the append options are set to include all channels of data, each channel of the source signal is appended into the same channel in the active window if that channel exists. What is copied varies based on the append options selected:

- With two channels of data in the source window, Ch. 1 and Ch. 2, then the Ch. 1 data from the source window is appended to the Ch. 1 data in the active window if data currently exists in channel 1 in the active window, and the Ch. 2 data from the source window is appended to the Ch. 2 data in the active window if data currently exists in channel 2.
- If the source waveform contains multi-channel data and the append options are set to include only the displayed channel (or the active channel, if all channels are displayed), the displayed (active) channel in the source window is appended to the displayed (active) channel in the active window.

Note When the range of data to be appended is **All Data**, the length of the data appended is determined by the length of the data in the displayed (active) channel in the source window. Data channels that are shorter than the displayed (active) channel are padded with zeros when appended.

6-4-5 Insert Source into Active

You can insert a range of waveform data from the source window into the waveform data in the active window.

To insert sampled data:

1. Ensure that a waveform is displayed in the source window. The active window must contain waveform data with the same sampling rate as the source.
2. Before you begin, you can want to check the various setup parameters for this operation. From the **Options** menu, select **Editing**, then select **Insert** from the displayed submenu to display a box in which you can select the data insertion features.

3. From the **Edit** menu, choose **Insert Source to Active**. You now have the option of inserting **All Source Data to Start of Active**, **Selected Source Data to Start of Active**, **All Source Data to Cursor in Active**, or the **Selected Source Data to Cursor in Active**.

The active window is redrawn with the specified range of source data inserted at the specified location. If a scrollbar is displayed in the window, the time scale is also updated to reflect the increased duration of data. Because of the method used to avoid clicks when joining signal endpoints, the resulting file can be slightly shorter than the sum of the lengths of the two components.

6-4-6 **Mix Source Data**

The program allows you to mix a range of waveform data in the source window with the waveform data in the active window. This is done by either adding the amplitude values together or by calculating the average amplitude values. The resulting waveform is displayed in the active window.

To mix sampled data:

1. Ensure that a waveform is displayed in both the source and active windows. If the source and active windows are the same, the range that is specified is mixed with the data starting at the beginning. If the source and active windows are not the same, the windows must contain waveform data of the same sampling rate.
2. The data in the active window will be replaced with the mixed data. If you do not want to lose the active window data, you can activate a different window or create a new window, then copy the data to the new active window.
3. From the **Options** menu, select **Editing**, **Mix** to display a dialog box which allows you to select the waveform mixing options.
4. To mix the two waveforms together, choose **Mix Source Data** from the **Edit** menu. Then select the region of data you wish to mix.

The source and active window data are mixed together and the resulting waveform is displayed in the active window.

6-4-7 **Source Signal Duration**

You can change the duration of the signal data in the source window without changing the pitch characteristics of the data.

To modify the duration of the data in the source window:

1. The default source window must contain waveform data. If the Signal Duration Options are set so that a new signal is generated, the active window must be empty.
2. Before changing the duration of the data, set the signal duration options. This can be done by selecting **Editing**, **Source Signal Duration** from the **Options** menu to display a box in which you can view and change the current settings.
3. To change the duration of the data in the source window, select **Modify Source Signal Duration** from the **Edit** menu. A submenu appears giving you the option to modify the duration of all the data (**All Data**), the selected region of the data (**Selected Data**), or the currently displayed data (**Displayed Data**).

The modified data is either spoken or displayed in the active window, depending on the setting of the rate modification output option. If the data is to be displayed, the active window must be empty. If the data is spoken, a playback toolbar is displayed during audio output of the modified data.

To halt audio output before the end of the data is reached:

- Click the **Stop** button or press the Enter key or Esc key.

To pause audio output temporarily:

- Click the **Pause** button or press the spacebar. When audio output is paused, the **Pause** button becomes a **Resume** button. Click the **Resume** button or press the spacebar to continue audio output at the point where it was halted.

Note: source window contains multi-channel data, only the data in the currently displayed channel are modified.

6-4-8 Filter Source Data

You can apply a **finite impulse response (FIR)** digital filter to a specified range of waveform data in the source window and copy the resulting filtered waveform to the active window. You must first build and save a filter file, or load an existing digital filter from disk. The most recently saved or loaded filter will be applied to the waveform data.

Build an FIR digital filter

Creates a finite impulse response (FIR) digital filter file using the parameters selected. The frequency response will be displayed in the RESPONSE window. Before the digital filter can be applied to sampled data, it must be saved as a filter file.

1. To begin, select **Editing**, **Filter** from the **Options** menu. A dialog box appears on the screen in which you can set the filter options.
2. Once you have set the filter parameters, click on the **Build** button to display the frequency response in the RESPONSE window within the FIR Filter Options dialog box. You can change any of the filter parameters and click on the **Build** button again to display the new filter profile.
3. Note that building a filter profile will only cause the program to display the frequency response. The filter is not available for use by the program until it has been saved to disk.
4. Click the **OK** button to close the FIR Filter Options box and install the most recently saved or loaded digital filter for use by the program. Click the **Cancel** button to close the FIR Filter Options box without installing a digital filter.

Save an FIR digital filter

Saves the filter coefficients of a recently built filter to disk.

1. Select **Editing**, **Filter** from the **Options** menu to display the FIR Filter Options dialog box, then build an FIR digital filter.
2. When you are satisfied with the filter that you have built, click on the **Save As** button. This will save the filter file to disk.
3. Click the **OK** button to automatically install the most recently saved filter file into the system, ready for use. This installed filter is used when a digital filter is applied to waveform data. Click **Cancel** to close the Filter Options box without installing the saved filter.

Load an Existing FIR digital filter

Displays a Load FIR Filter Description box in which you can select an existing filter to install. The filter is loaded into memory and the corresponding frequency response is displayed in the RESPONSE window of the dialog box. The Window, Type, Cutoff and Filter Order boxes will display the settings used when the filter was created.

1. Select **Editing**, **Filter** from the **Options** menu to access the FIR Filter Options box. Now click on the **Load** button. Scroll to the location of your filter files, then select the file you wish to load from the list of available filter files. Click the **OK** button or press the Enter key to complete the file loading routine.
2. The filter is loaded into memory and the corresponding frequency response is displayed in the RESPONSE window of the Filter Options dialog box. The **Window**, **Type**, **Cutoff** and **Filter Order** boxes will display the settings used when the filter was created.
3. Click **OK** to install the loaded filter for use by the program. Click **Cancel** to close the FIR Filter Options box without installing the most recently loaded filter.

Apply an FIR Digital Filter

Applies the installed FIR digital filter to the waveform data in the default source window.

1. Ensure that a waveform is displayed in the source window. If the source and active windows are the same, the range that is specified in the source window is replaced by the filtered data. If the source and active windows are not the same, then the active window must be empty.
2. To filter the waveform data, select **Filter Source Data** from the **Edit** menu. Then select **All Data** to apply the filter to all the waveform data, **Selected Data** to filter the data in the selection area, or select **Displayed Data** to filter the data currently displayed in the default source window.
3. If no finite impulse response (FIR) filter is installed, the Filter Options box is displayed, allowing you to build and save a new filter, or load an existing digital filter.
4. The data are filtered using the installed digital filter, and the resulting waveform is drawn in the active window. Compare the original and filtered waveforms visually by generating power spectra at similar locations in each. You can also listen to the differences by speaking each in turn. If desired, you can Downsample Displayed Source

The program provides the facility for downsampling a range of sampled data in the source window. The resulting waveform data is displayed in the active window.

Downsampling is typically used to reduce the sampling rate of a waveform after it has been filtered. The combination of downsampling and filtering can be used to remove possible aliasing effects from digitally encoded waveform data.

Note Anti-aliasing is carried out automatically during data capture. However, you can wish to filter, then downsample the data to change the bandwidth of sampled data without recapturing the data.

To downsample sampled data:

1. Ensure that a waveform is displayed in the source window. Unless all the data in the source window are to be downsampled, the source and active windows must be different, and the active window must be empty.
2. To downsample the waveform data displayed in the source window, choose **Downsample Displayed Source** from the **Edit** menu. A dialog box appears on the screen, displaying the present sampling rate and a list of allowed rates that the data can be downsampled to. Select a new downsampling rate from the list.
3. The sampling rate of the data is changed to the selected rate and the resulting waveform is displayed in the active window. You can verify the new sampling rate by selecting **Information on Active Window** from the **Window** menu.

6-4-9 **Scale Displayed Source**

The program includes a scaling operation which multiplies the amplitude values in a range of sampled data in the source window by a specified scaling factor, and then displays the resulting scaled waveform in the active window.

To scale sampled data:

1. Ensure that a waveform is displayed in the source window. If the source and active windows are the same, the range that is specified in the source window is replaced by the scaled data. If the source and active windows are not the same, then the active window must be empty.
2. To scale the displayed waveform data, choose **Scale Displayed Source** from the **Edit** menu. A dialog box appears on the screen, allowing entry of the scaling factor.
3. The amplitude values of the source waveform data are multiplied by the scaling factor and the resulting waveform is displayed in the active window. If scaling produces amplitude values that are greater than the maximum allowed dynamic range (amplitude values ranging from +32,767 to -32,768), the values are scaled to the maximum.

6-4-10 **Pre-Emphasis Displayed Source**

You can apply a pre-emphasis factor to a range of sampled data in the source window and display the results in the active window.

To apply pre-emphasis factor to sampled data:

1. Ensure that a waveform is displayed in the source window. If the source and active windows are the same, the range that is specified in the source window is replaced by the pre-emphasized data. If the source and active windows are not the same, then the active window must be empty.
2. To apply pre-emphasis to the displayed waveform data, choose **Pre-emph Displayed Source** from the **Edit** menu. A box will appear, asking for entry of the pre-emphasis factor.
3. Pre-emphasis operates on the waveform by multiplying the amplitude of the current sampled data point by a factor ranging from 0.0 to 2.0, then subtracting it from the amplitude of the next sampled data point, repeating this process for all data specified in the range. The pre-emphasized waveform is displayed in the active window.

6-4-11 **Subtract Displayed Source**

You can compute the differences between waveform data in a specified range in the source window and waveform data of the same sampling rate in the active window. The resulting differenced waveform will be displayed in the active window.

To difference sampled data:

1. Ensure that a waveform is displayed in both the source and active windows. Remember that the source window data are subtracted from the active window data. If the durations of the data in the two windows are not the same, the remaining undifferenced data are appended to the end of the differenced waveform. If the source and active windows are the same, the range that is specified is replaced by the differenced data. This has the effect of converting the data in the specified range to zeros.
2. The data in the active window will be replaced with the differenced data. If you do not want to lose the active window data, you can create a new window, and then copy the data to the new window.
3. From the **Edit** menu, choose **Subtract Displayed Source** to subtract the displayed source data from the active window data.
4. The amplitude values of the specified range of source data are subtracted from the amplitude values of the data in the active window. The resulting differenced waveform is displayed in the active window.

6-4-12 **Flip Displayed Source**

You can reverse the polarity of a range of sampled data in the source window and display the resulting waveform in the active window.

To flip a waveform signal:

1. Ensure that a waveform is displayed in the source window. If the source and active windows are the same, the range that is specified in the source window is replaced by the inverted data. If the source and active windows are not the same, then the active window must be empty.
2. To flip the waveform signal, choose **Flip Displayed Source** from the **Edit** menu. This will cause all of the displayed data in the source window to be flipped.
3. The polarity of the source waveform data is reversed and the resulting waveform is displayed in the active window.
4. You can want to zoom in on a region of the waveform to have a closer look at the signal polarity. Select a voiced section of data, and then choose **Selected Data** from the **View** menu to display the selected section of data.

6-4-13 Reverse Displayed Source

You can reverse the time domain of a range of sampled data in the source window and display the resulting waveform in the active window.

To reverse sampled data:

1. Ensure that a waveform is displayed in the source window. If the source and active windows are the same, the range that is specified in the source window is replaced by the reversed data. If the source and active windows are not the same, then the active window must be empty.
2. To reverse the displayed waveform data, choose **Reverse Displayed Source** from the **Edit** menu.
3. The time domain of the source waveform data is reversed and the resulting waveform is displayed in the active window. You can listen to the reversed data.

6-4-14 Multi-Channel Functions

Note The program now supports the display of more than one channel of data in the window.

Split from Next Channel in Source

If the waveform signal in the source window is a multi-channel signal, you can split a single channel from it and place that channel of data in an empty active window.

To split a channel of data from a multi-channel signal:

1. Ensure that a multi-channel signal is displayed in the source window. If you do not have a multi-channel signal, you can create one by joining signals. Note that the source window cannot be the active window.
2. The active window must be empty prior to command execution.
3. From the **Edit** menu, choose **Multi-Channel Functions**, **Split from Next Ch. in Source** to split the next-to-displayed channel of the source data into the active window. If all channels of data are displayed, the next-to-active channel is split from the source data.
4. For example, if the source window contains a signal with 4 channels of data (Ch. 1 through Ch. 4) and only Ch. 3 is displayed, then the Ch. 4 data will be split from the source signal into the empty active window. Alternatively, if all 4 channels are displayed in the source window and Ch. 3 is active channel (i.e., the Ch. 3 pane is active in the source window), again, the Ch. 4 data is split.
5. The channel of data that was split from the multi-channel signal is now displayed in the active window. You can listen to the new data, and optionally save the data in the active window as a new signal data file.

Join as Next Channel in Source

You can merge single-channel waveform data in the active window with the waveform data in the source window, removing the data in the active window and creating a multi-channel signal of up to eight (8) channels in the source window. Note that when you save the waveform data, not all audio file formats support multi-channel signals.

To create multi-channel data:

1. Ensure that a waveform is displayed in the source window, and that the active window contains single-channel data having the same sampling rate as the source data. If the data in the active window is multi-channel, you will have to split the signal to create single-channel data.
2. To join the data from the active window to next available channel after the displayed channel in the source window, choose **Multi-Channel Functions**, **Join as Next Ch. in Source** from the **Edit** menu. If all channels of data are displayed in the source window, the signal in the active window is joined as the next-to-active channel in the source window.
3. For example, if the source window contains a signal with 3 channels of data (Ch. 1 through Ch. 3) and only Ch. 3 is displayed, then the data in the active window will be joined to the source data as Ch. 4. Alternatively, if all 3 channels are displayed in the source window and Ch. 3 is active channel (i.e., the Ch. 3 pane is active in the source window), again, the data are joined as Ch. 4.
4. The data in the active window are removed and joined to the source data. The joined data are time aligned so that they have the same duration as the source. If the duration of the data in the active window is greater than the data in the source window, the active window data are truncated to the duration of the source. If the duration of the active window data is less than the duration of the data in the source, zeros are added to the end of the active window data to make its duration equal to the source.
5. You can optionally save the newly created multi-channel data. Note that up to eight (8) channels can be saved in CSL signal file format. Wave audio file format supports a maximum of two (2) channels of data, and the supported headerless audio file formats allow storage of single-channel data only.

6-4-15 **Edit Voiced Period Marks**

Due to the varying nature of sampled data, errors in the placement of voiced period marks, or impulse marks, can result. Such errors affect any pitch-synchronous analyses that are subsequently performed. You can manually add voiced period marks to the data, creating frame boundaries that are independent of the pitch. You can also edit the placement of voiced period marks that already exist in the waveform data and are displayed in the active window along with their associated waveform data.

Note that voiced period marks will not be displayed unless the signal display options are set to show them with the waveform.

Move impulse marks

1. Ensure that a waveform is displayed in the active window, and that voiced period marks are displayed in the waveform data.
2. This command is used to change the location of voiced period marks, either to correct for processing errors or to move them to a new location relative to the voiced period. Use the following commands to make these changes:
    - To move the voiced period mark to the left of the cursor to the cursor location, choose **Voiced Period Marks**, **Move Previous Impulse to Cursor** from the **Edit** menu.
    - To move the voiced period mark to the right of the cursor to the cursor location, choose **Voiced Period Marks**, **Move Next Impulse to Cursor** from the **Edit** menu.
3. After editing the voiced period marks, you can want to save the changes. To do this, choose **Save** from the **File** menu.

Manually add an impulse mark

1. Ensure that a waveform is displayed in the active window, and that the window is set to display voiced period marks.
2. To insert a voiced period mark at the current cursor location in the waveform data, choose **Voiced Period Marks**, **Add Impulse at Cursor** from the **Edit** menu.

Delete impulse marks

1. Ensure that a waveform is displayed in the active window, and that voiced period marks are displayed in the waveform data.
2. To delete a voiced period mark at the current cursor location in the waveform data, choose **Voiced Period Marks**, **Delete Impulse at Cursor** from the **Edit** menu.
3. You can also delete voiced period marks in a specific range of data. To delete voiced period marks within the selected region of the data, choose **Voiced Period Marks**, **Delete Impulses in Selected Data** from the **Edit** menu.

6-5 Impulse Marks

You can compute the periodicity of voiced speech in the active window and place marks in the waveform data at time locations that separate the voiced periods. These marks are referred to as **voiced period marks**, or **impulse marks**. The process separates the voiced signal into its periodic components, the inverse of each period being the fundamental frequency, or pitch separation, of the signal as it changes over time.

6-5-1 Impulse Analysis

Note that voiced period marks must be inserted in the waveform data before pitch-synchronous analysis can be performed on the sampled data.

Placement of the voiced period marks can be edited.

6-5-2 Display impulse marks

Voiced period marks can be present in the waveform but hidden from view.

1. To display the marks in the active window, select **Waveform** from the **Options** menu to display a dialog box in which you can set the signal attributes to display. Enable the **Impulse Marks** checkbox, causing a check mark to appear in the check box.
2. Remove the voiced period marks from the window without deleting them from the waveform data by clearing the **Impulse Marks** checkbox in the Signal Display Options dialog box.

6-5-3 Manually add an impulse mark

You can manually add impulse marks at locations along a waveform as desired. To insert impulse marks to a waveform:

1. At the **Options** menu, select **Waveform**.
2. Under Display options, ensure the box next to **Impulse Marks** is checked.
3. Click **Apply** after selection if necessary, then **OK** to close the window.
4. **Left-click** the desired location in the waveform. The red data cursor will move to that location.
5. At the Edit menu, go to the submenu **Voiced Period Marks**, and select **Add Impulse at Cursor**.\

6-5-4 Compute and insert impulse marks

To compute and insert impulse marks:

1. Ensure that a waveform is displayed in the active window.
2. Before generating the voiced period marks, set the impulse analysis parameters. This can be done by selecting **Analysis**, **Voiced Period Marks** from the **Options** menu to display a box in which you can view and change these parameters.
3. To compute and insert voiced period marks into the data, choose **Voiced Period Marks** from the **Analysis** menu. A dialog box appears in the work area giving you the option to compute the voiced period marks on all the data by selecting **All Data**, the selected region of the data by choosing **Selected Data**, or the currently displayed data by selecting **Displayed Data**.
4. The waveform is redrawn with the voiced period marks inserted. If the voiced period marks are not displayed in the waveform, you must change the **signal display options** so that these marks will be displayed.
5. You can optionally save the sampled data with the voiced period marks.

6-5-5 Delete impulse marks

1. Ensure that a waveform is displayed in the active window, and that voiced period marks are displayed in the waveform data.
2. To delete a voiced period mark at the current cursor location in the waveform data, choose **Voiced Period Marks**, **Delete Impulse at Cursor** from the **Edit** menu.
3. You can also delete voiced period marks in a specific range of data. To delete voiced period marks within the selected region of the data, choose **Voiced Period Marks**, **Delete Impulses in Selected Data** from the **Edit** menu.

6-5-6 Move impulse marks

To change the position of voiced period marks, either to correct for errors or relative to voiced period:

1. Ensure that a waveform is displayed in the active window, and that voiced period marks are displayed in the waveform data. Do ONE of the following:
   - To move the voiced period mark to the left of the cursor to the cursor location, choose **Voiced Period Marks**, **Move Previous Impulse to Cursor** from the **Edit** menu.
   - To move the voiced period mark to the right of the cursor to the cursor location, choose **Voiced Period Marks**, **Move Next Impulse to Cursor** from the **Edit** menu.

6-5-7 Pitch Analysis

The program allows you to compute the fundamental frequency (pitch) of a range of voiced data in the source window and display the resulting pitch contour in the active window.

To create a pitch contour:

1. Ensure that a waveform is displayed in the source window. The active window must be empty or contain time domain analysis data prior to command execution.
2. Before generating the pitch contour, set up the pitch analysis parameters. This can be done by selecting **Analysis**, **Pitch Contour** from the **Options** menu to display a box in which you can view and change these parameters.
3. If pitch-synchronous analysis is performed, the fundamental frequency values are extracted by computing the inverse of the time between each voiced period mark (impulse mark) in the data. If impulse marks are not in the signal when pitch-synchronous analysis is performed, the pitch synchronous analysis process will compute the impulse locations and store them internally. If impulse marks are in the signal, then the impulse locations in the signal are used.
4. If pitch-asynchronous (fixed frame) analysis is performed, the fundamental frequency is extracted directly from the waveform by determining the time intervals between dominant peaks in the waveform. The waveform is first broken into regular intervals (frames), the duration of which is set by the user. Note that frame length must be set to at least two pitch periods to achieve good results.
5. Interpolation is applied to the pitch analysis results (pitch synchronous or fixed frame) in order to improve the resolution of the pitch analysis process.

6. To generate a pitch contour, select **Pitch Contour** from the **Analysis** menu. A submenu appears in the work area giving you the option to create a pitch contour on all the data (**All Data**), the selected region of the data (**Selected Data**), or the currently displayed data (**Displayed Data**).
7. The resulting pitch contour is drawn in the active window. Numerical results and result statistics can now be displayed, and optionally printed and saved, or copied to the clipboard then pasted into a spreadsheet.

6-5-8 Energy Analysis

You can compute the energy of a range of waveform data in the source window and display the resulting energy contour in the active window.

The energy operation calculates the sum of the absolute amplitude values in a frame of data divided by the number of points in the frame. The energy is first computed and then converted to decibels of sound pressure (dB SPL).

To create an energy contour:

1. Ensure that a waveform is displayed in the source window. The active window must be empty or contain a time series of analysis data.
2. Before generating an energy contour, set the energy analysis parameters. This can be done by selecting **Analysis**, **Energy Contour** from the **Options** menu to display a box in which you can view and change these parameters.
3. To create an energy contour, select **Energy Contour** from the **Analysis** menu. A submenu appears in the work area giving you the option to create an energy contour on all the data by selecting **All Data**, on the selected region of data by selecting **Selected Data,** or on the currently displayed data by selecting **Displayed Data**.
4. The resulting energy contour is drawn in the active window. Numerical results and result statistics can now be displayed, and optionally printed and saved, or copied to the clipboard then pasted into a spreadsheet.

6-5-9 Impulse-Driven Data Cursor Movement

If the active window contains waveform data and voiced period marks (impulse marks) have been placed in the data, you can move the data cursor from its current location to the location of the next or previous voiced period mark:

1. From the **Edit** menu, select **Voiced Period Marks**. To move the data cursor to the location of the voiced period mark that precedes the current cursor location, select **Go to Previous Impulse**. To move to the voiced period mark that follows the current cursor location, select **Go to Next Impulse**.
2. If the active window contains waveform data and tags are in the data, you can move the data cursor from its current location to the location of the tag immediately to the left or right of the current cursor location. To move the data cursor to the location of the tag that precedes the current cursor location, select **Go to Previous Tag** from the **Tags** menu. To move the data cursor to the location of the tag that follows the current cursor location, select **Go to Next Tag** from the **Tags** menu.

3. Acquire or load data into an empty window (e.g., Window A) and select a window for plotting analytical results (e.g., Window B).

   If the waveform source window (e.g., Window A) is still active when an analysis operation is called, The CSL Main Program and Multi-Speech will automatically activate the next empty window in the work area before performing the requested operation.

4. Select an analysis technique by clicking **Analysis** on the Main Menu and then select the desired analysis mode (e.g., **Spectrogram**).

5. Select which portion of the signal you would like to analyse (e.g., **All Data**, **Selected Data**, etc.).

6. If you wish to adjust some of the analysis set parameters (e.g., spectrogram bandwidth), you can alter all of these set parameters from the menu by selecting **Analysis** on the Main Menu, then **Spectrogram**, and then **Adjust Spectrogram Analysis**.

   Alternatively, right-click in the window containing the spectrogram, then select SPG Setup from the displayed pop-up menu. From the dialogue box displayed in Figure 22 below, you can now alter the setup parameters to suit your analysis requirements, and then apply desired settings to the existing analysis.

7. Click on the new selection, and then click **OK** to accept these changes for the next analysis or click **Apply** to apply the changes to the current SPG analysis results in the active window

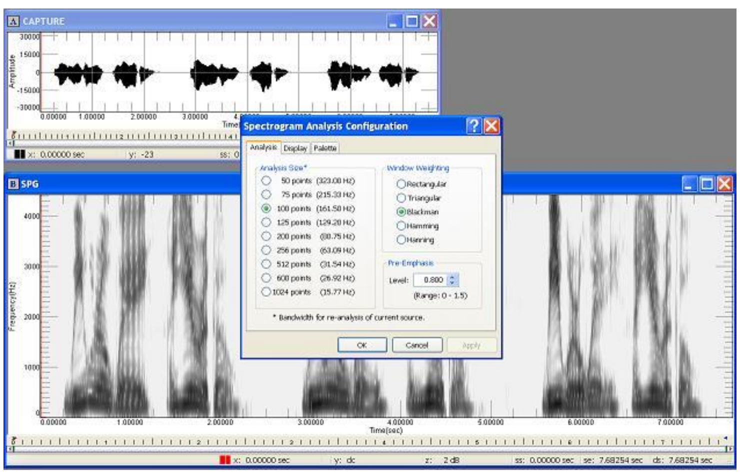

Figure 22. Spectrographic Analysis Settings

   Note that any number of compatible analysis results can be overlaid in a window. For example, Spectrogram, Formant History, Pitch Contour and Energy Contour results are all displayed over a time domain.

8. To overlay an LPC-based time history formant display over the spectrogram in Window B, click **Analysis** on the Main Menu and then select **Formant History**.

9. From the **Formant History** submenu, select which portion of the signal you would like to analyze (e.g., **All Data**, **Selected Data**, etc.).

10. The title of the window changes from SPG to FMT, and the formant history is drawn on top of the spectrogram.

The formant history shown below is laid over the spectrogram using large dots, and with a different pen color assigned to each formant.

You can display numerical results for the formant analysis on the screen:

1. Click on the **Analysis** menu, and then select **Produce Numerical Results**. Alternatively, press the [Alt+R] keys to display the numerical results for the active window.

   A Formant Analysis Results box is displayed in the work area, giving the option to save the data to a file, print the data, or display information about the analysis option settings and the source data used for the analysis.

2. After reviewing the data, click the **Done** button to close the Formant Analysis Results box.
3. To avoid cluttering the window, remove the formant history before plotting the pitch and energy of the signal. Click on the **View** menu, and then select **Remove Current (Top) Plot**. Note that instead of using the menu, you can press the [Ctrl+End] keys on the keyboard to remove the top plot in the window.

   The formant history is removed from the window and the spectrogram is again displayed. The title of the window changes back from FMT to SPG.

In preparation for pitch-synchronous analysis of the sampled data, you can compute the locations of the voice period separations in the speech waveform data and place marks in the waveform data at these time locations. These marks are called voiced period marks, or impulse marks.

To compute impulse mark locations:

1. To begin, click on the title of Window A to activate it.
2. Click on **Analysis** on the Main Menu, and then select **Voiced Period Marks**.
3. From the **Voiced Period Marks** submenu, select which portion of the signal you would like to analyze (e.g., **All Data**, **Selected Data**, etc.).

   The impulse marks are inserted along the bottom of the waveform data.

4. Click Window B to reactivate it.
5. Analysis parameters can be set before the analysis is performed. Prior to plotting a pitch contour in the active window (i.e., Window B); select **Analysis** on the Main Menu, then **Pitch Contour**, and then **Adjust Pitch Contour**. In the displayed Pitch Analysis Options dialog box, click the Display tab to access the display settings, and then clear the **Draw Dot Contour** checkbox to display the pitch contour as a solid line.
6. Now to perform the pitch analysis, select **Analysis** on the Main Menu, then select **Pitch Contour**.
7. From the **Pitch Contour** submenu, select which portion of the signal you would like to analyze (e.g., **All Data**, **Selected Data**, etc.).

   The title of the active window changes from SPG to PITCH, and a pitch contour is overlaid on the spectrogram using the active pen color, which is reported by the leftmost color swatch on the window status line.

   Initially, both the current (active) plot pen color and the next plot pen color are both set to black. However, either of these color values can be changed by double-clicking on the color swatch at the bottom of the window, the leftmost of the two small lines to the left of "x".

8. To change the color of the next plot in Window B, double-click on the rightmost color swatch and then click on the Forest Green swatch in the displayed color panel. The color swatches on the status line should now be red (left) for the current plot and green (right) for the next plot.

9. Finally, we will overlay an energy contour for a portion of the waveform data on top of the spectrogram and pitch contour in Window B. Select **Analysis** on the Main Menu, then select **Energy Contour**.
10. From the **Energy Contour** submenu, select which portion of the signal you would like to analyze (e.g., **All Data**, **Selected Data**, etc.).

    The title of the active window changes from PITCH to ENERGY, and a green colored energy contour is overlaid on the spectrogram and the pitch contour, as shown below.

    Both color swatches on the window status line are now green, as the active (i.e., energy) plot was drawn using this pen color. The green energy contour is the current (top) plot, as indicated by ENERGY in the Window B title bar and by the leftmost color swatch on the Window B status line.

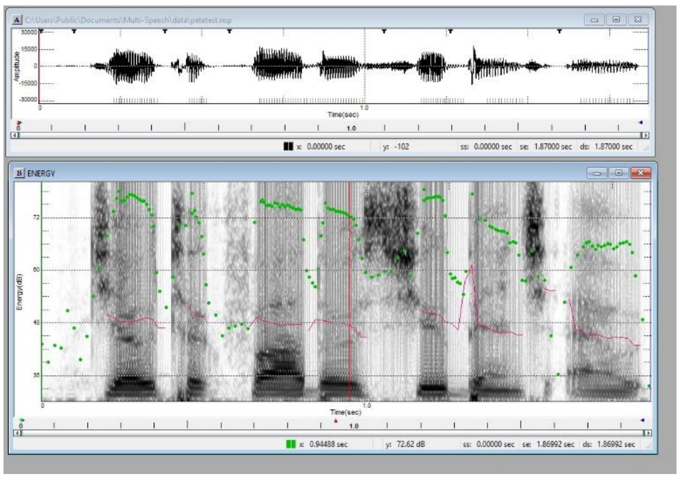

Figure 23. Pitch and energy contours overlaid on spectrogram.

To move the data cursor through the analysis data:

Press the [Right arrow] key or the [Ctrl+Right arrow] key combination to move at a faster rate. Alternatively, click the mouse on the red data cursor and, holding the mouse button down, drag it to a new location in the data. The x-axis and y-axis values on the window status line are updated to reflect the time and energy (dB) values of the data at the cursor location.

With multiple analysis plots in a window, you can scroll through the analysis data, causing the current data to move to the end of the analysis results list and the previous data to become current (i.e., topmost in the list):

1. Select **View** on the Main Menu, and then select **Put Previous Plot on Top**.
2. The energy contour is "hidden" behind the spectrogram and the pitch contour is now active. The title of Window B changes from ENERGY to PITCH, and the leftmost color swatch on the window status line changes to red, indicating the pen color of the pitch contour display. The y-axis box now reports the fundamental frequency (Hz) value of the data at the current cursor location.

    Both the analysis results in Window B and the source waveform in Window A are displayed over a Time (sec) dimension. Therefore, cursor movement, data mark movement, selection area definition, and data display operations in the two windows can be linked.

3. To link these operations in the two windows, click **Window** on the Main Menu, then select **Link Windows.** Finally, select **Link to Source Window** from the displayed submenu.

   Now as you move the data cursor through the analysis results in Window B, the cursor movement is replicated in Window A. Again, move the data cursor in Window B using the keyboard or mouse, and notice that cursor movement in Window A is time-aligned with the cursor movement in Window B.

   Notice that the values in the x-axis boxes on both window status lines are the same. From the y-axis box in Window A, we can read the amplitude of the waveform at a point in time, and from the y-axis box in Window B, we can read the pitch analysis value produced from the waveform data.

When windows are linked, data display operations are also duplicated in the linked windows. To illustrate, we will display only the data from the start to the current cursor location:

1. Select **View** from the Main Menu, and then select **Start to Cursor**. Alternatively, press the [Alt+C] keys.

   Both Window A and Window B are redrawn, showing only the first portion of the data in each.

2. To redisplay all data in the windows, click **View** on the Main Menu, then select **All Data**. Alternatively, press the [Alt+A] keys.

   Again, both linked windows are redrawn to display all data.

3. To calculate Result Statistics for the pitch analysis data, click **Analysis** on the Main Menu, then select **Compute Result Statistics**, or press [Alt+S].

   A Pitch Result Statistics box is displayed. You have the option to save the data to a file, print the data, or display information about the analysis option settings and source data used for the analysis.

4. After reviewing the data, click the **Done** button to close the Pitch Result Statistics box.

Frequency Axis Results

The prior steps have shown the results of analyses that are displayed over a time axis. Power spectra and frequency response data, however, are displayed on a frequency axis as follows:

1. Clear any data from Window B by clicking **Window** on the Main Menu, then selecting **Purge Active Window**. Alternatively, you can press the [F2] function key.
2. The contents of Window B are erased, and the link between Window A and Window B is automatically removed.
3. Click the **Minimize** button in Window B.
4. To open a new window to display the frequency response data. click **Window** on the Main Menu, and then select **Open Preset Window**. Finally, select **For Frequency Response etc.** from the displayed submenu.

   A new active window is displayed in the work area with the label "C Empty."

5. Click on the title of Window A to activate it.
6. Move the data cursor to the location of a vowel sound in the source waveform.
7. Reactivate Window C by pressing either the [Page Up] or the [Page Down] key on the keyboard.

8. Click **Analysis** on the Main Menu, and then select **LPC Frequency Response**. Finally, select **LPC Frequency Response at Cursor** from the displayed submenu.

   The frequency response data are displayed in the active window and the window title reads LPC.

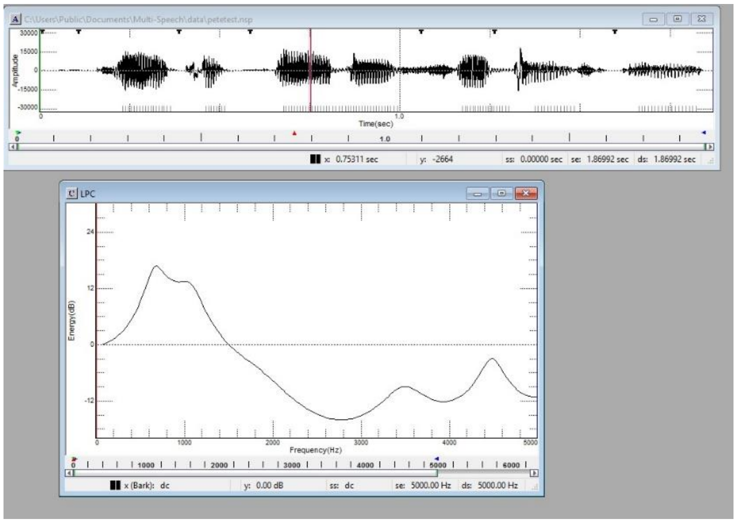

Figure 24. LPC Frequency Response.

9. Note that LPC Frequency Response and FFT Power Spectrum analysis results are displayed over a frequency axis; therefore, these data can optionally be plotted in the same window.

This concludes our overview of many of the analysis functions that are available.

6-6 Tagging Data

The program allows you insert tags at specified locations in the waveform display, and to manipulate a tag at a location or all tags in a range of waveform data in the active window.

6-6-1 View Tags in Waveform Data

Tags are arranged in consecutive numerical order starting with **T1**, and are location dependent. If a tag is placed at a location before an existing tag, the tag numbers are reordered so that the first tag in the waveform is always **T1**.

To enable display of tags:

1. Ensure that a waveform is displayed in the active window. Tags must already exist in the waveform data for all tag operations except inserting new tags. To determine if tags are present, select **Information on Active Window** from the **Window** menu. If tags are present, a check mark will appear in the box beside the tag description.
2. Tag marks can be present in the waveform but hidden from view. To display the tags, select **Waveform** from the **Options** menu to display a dialog box in which you can set the signal attributes to display. Select **Tags**, causing a check mark to appear in the box beside the Tags description. Remove the tags from the window without deleting them from the waveform data by clearing the **Tags** box in the Signal Display Options dialog box.

3. You can insert tags in a waveform, delete existing tags, move tags to a new location, display the tag comment information, and edit the comment information for a tag.
4. You can save any changes that you make to the tags in the waveform. Note that you must save the data in CSL signal file format to store the tag information with the waveform, as wave audio file format does not support this type of information.

6-6-2 **Insert Tag**

To insert a tag with an optional comment field at the current cursor location in the waveform data:

1. At the **Tags** menu. choose **Insert Tag at Cursor**.
2. Enter text to identify tag to be saved along with its location in the file.
3. Click **OK** to insert the tag.

6-6-3 **Delete Tag**

To delete the tag at the current cursor location:

- At the **Tags** menu. select **Delete Tag at Cursor**.

To delete all tags within the selection area:

- Select **Delete Tags in Selected Data** from the **Tags** menu.

6-6-4 **Edit Tag**

To edit the comment information for the tag at the current cursor location:

1. Choose **Edit Tag at Cursor** from the **Tags** menu.

   An Edit Tag Text dialog box is displayed, showing the time location of the tag and the textual information in the comment field.
2. Edit the comment field.
3. Click **OK** to save the change, or click **Cancel** to close the Edit Tag Text box without saving changes made to the comment field.

6-6-5 **Display Tag Comment Field**

To display the comment information for a tag at the current cursor location, choose **Query Tag at Cursor** from the **Tags** menu. A box displays the time location of the tag and the text in the tag comment field.

6-6-6 **Move Tag**

To move the tag to the left of the data cursor to the current cursor location, select **Move Previous Tag to Cursor** from the **Tags** menu. To move the tag to the right of the data cursor to the current cursor location, select **Move Next Tag to Cursor** from the **Tags** menu.

6-7 IPA Characters and Transcription

You can add, delete, copy, or move International Phonetic Alphabet (IPA) symbols at a specified location in the waveform in the active window. You can then save the transcribed waveform data to a file using CSL signal file format. (Note that wave audio file format does not support storage of IPA characters with the waveform data. If you save the signal data as a WAV file, the IPA transcripts will be lost.)

6-7-1 Prepare for IPA Transcription

Before you begin, ensure that one or both of the IPA transcription lines are displayed in the window. If both lines are displayed, you must specify which one is the active line for IPA operations.

1. IPA characters can be stored with waveform data in a sampled data file. However, IPA transcripts will not be displayed in the window with the waveform data unless the program has been set to display the IPA transcription lines. To display one or both IPA lines, select **Waveform** from the **Options** menu to display a dialog box in which you can set the signal attributes to display. Then select one or both of the transcription line boxes, **Upper** or **Lower**.
2. If both are transcription lines are displayed, radio buttons are activated allowing you to select which transcription line is active (editable). Symbols in the active line will be drawn in black, while symbols in the inactive line will be in gray. Alternatively you can select the active transcription line by selecting **IPA Transcription** from the **Options** menu to display a dialog box in which you can select the Active Transcription Line, either **Line 1** (Upper) or **Line 2** (Lower).
3. You can also specify the size of the font used when displaying IPA symbols in the window. Select **Waveform** from the **Options** menu to display a dialog box for selecting signal display options. In the Transcription Font area of this dialog box, click on the Down Arrow to display a drop box of valid **font** sizes. Scroll through the list of available font sizes and select the size you wish to use to display the IPA symbols.
4. When entering IPA characters using the transcription box, you can set the font size for the display of the characters in the box. From the **Options** menu, select **IPA Transcription** to display the IPA Transcription Options dialog box. In the Editor Font section of the dialog box, select the desired **font** size from the dropdown box.
5. Finally, when using the transcription box, you have the option of inserting the IPA characters into the active window, if it contains signal data, or into the window containing the source signal for the time domain analysis data in the active window. From the **Options** menu, select **IPA Transcription** to display the IPA Transcription Options dialog box, then select **Active** or **Source** in the Insert Into section of the dialog box.
6. Whenever you make changes to the settings in an Options dialog box, click **Apply** to apply the changes to the active window containing waveform data. Click the **OK** button to save the changes and close the box. Click **Cancel** to clear the dialog box without saving the changes.

6-7-2 Insert IPA Characters Using the Transcription Box

An IPA Characters transcription box has been developed as an alternative method of inserting IPA symbols into waveform data.

1. Ensure that a waveform is displayed in the active window and that at least one transcription line is displayed in the window. There can or cannot be IPA symbols already present in the waveform data.
2. To display the IPA Characters transcription box, select **Display IPA Symbol Table** from the **IPA** menu.
3. Click on any of the IPA Characters in the displayed symbol table.
4. As an aid to transcription, you can click the **Description** button to display information about the selected symbol.
5. To insert the selected IPA Character at the current cursor location, click the **Insert** button. Remember that IPA Characters are inserted in the waveform in either the active window or the window containing the source signal for the time domain analysis data in the active window, depending on the settings for the IPA Options.
6. When you have finished transcribing the waveform, remove the IPA Characters transcription box from the screen by selecting **Remove IPA Symbol Table** from the **IPA** menu.

6-7-3 Insert IPA Characters Using the Keyboard

Using the keyboard, you can insert IPA characters into the waveform data in active window.

1. Ensure that a waveform is displayed in the active window and that at least one transcription line is displayed in the window. There can or cannot be IPA symbols already present in the waveform data.
2. Configure the keyboard for the purpose of entering IPA symbols. Select **Load IPA Symbols to Keyboard** from the **IPA** menu to load the IPA characters to the keyboard.
3. Press the appropriate key or key combination for the IPA symbol you wish to insert at the current cursor location. Refer to **Appendix** F **IPA Characters** for detailed information on entering IPA symbols in this manner.
4. When you are finished transcribing the speech data, reload the keyboard definitions for normal program operation. Select **Restore Keyboard to Normal** from the **IPA** menu.
5. The Information dialog box for the waveform signal will show that IPA Transcriptions have been added to the waveform. You can save any changes that you have made to the sampled data file. To save the sampled data with the added IPA symbols, choose **Save** from the **File** menu.

6-7-4 Delete IPA Characters

1. Ensure that a waveform is displayed in the active window. IPA characters must already be present in the waveform data.
2. To delete an IPA character and associated comment information at the current cursor location, select **Delete IPA Symbol at Cursor** from the **IPA** menu. To delete IPA characters in the selected region of the waveform, select **Delete IPA Symbol in Selected Data** from the **IPA** menu.

6-7-5 Move IPA Characters

1. Ensure that a waveform is displayed in the active window command. IPA characters must be present in the waveform data.
2. You can move the IPA symbol preceding the data cursor to the cursor location by selecting **Move Previous IPA Symbol to Cursor** from the **IPA** menu. Move the IPA symbol following the data cursor to the cursor location by selecting **Move Next IPA Symbol to Cursor** from the **IPA** menu. An IPA character must exist at the first location and not exist at the second location. Use this command to fine tune character placement.

6-7-6 IPA Transcription Options

From the **Options** menu, select **IPA Transcription**. You can set the following IPA Transcription Options:

- **Active Transcription Line** - One or two data fields can be optionally displayed for entry of IPA characters. If both of the available IPA transcription lines are displayed, specifies which line is active. Note that if only one transcription line is displayed, it is automatically set as the active line.
- **Insert Into** - When using the transcription box, you have the option of inserting the IPA characters into the active window, if it contains signal data, or into the window containing the source signal for the time domain analysis data in the active window.
- **Editor Font Size** - When entering IPA characters using the transcription box, specifies the font size to display the characters in the box.

6-7-7 Load IPA Keyboard Definitions from a File

1. You can assign keyboard definitions from a specified file. For example, the file IPA.KEY contains keyboard definitions for IPA characters. Refer to the IPA Character Charts and Tables in **Appendix** F **IPA Characters** of this instruction manual for more information.
2. To load these IPA keyboard definitions to the keyboard, select **Load IPA Symbols to Keyboard** from the **IPA** menu.
3. Note that you must press the spacebar to access the command line when the IPA keyboard definitions are loaded.
4. To reload the keyboard definitions for normal program operation, select **Restore Keyboard to Normal** from the **IPA** menu.

6-8 Logging

The program offers the ability to record information taken from the current cursor location and save it in an ASCII text file, called a log book. Note that only one log file can be opened at a time.

6-8-1 Open an Existing Log File

You can open a previously created log file to review the existing records and to add new data. To reopen an existing log file:

➢ Select **Open** from the **Log** menu. An Open Log Book dialog box is displayed, allowing you to select the log file you wish to reopen from the list of existing log files.

  A message is displayed in the work area, confirming that the log book has been opened. Each time a log book is opened, a special Time Stamp comment containing both the time and date at which the log was opened is entered into the log file.

6-8-2 Create a New Log File

To open a log file for the first time:

1. Select **Open** from the **Log** menu.

   An Open dialog box is displayed, requesting entry of a name for the log file. Type a name for the log book in the **File Name** box. A .LOG extension is automatically added to the file name.

   Once you have named the new log file, a Create Results Log information box appears in the work area. You can have up to eight fields in each log record. For each field, select the type of information that the field is to contain, and optionally assign a label to the field. You must also select a field separator. The different fields appear as columns of information in the log file.

2. Click the **OK** button after defining the fields for your log book.

   Once a log book has been initialized, its fields and field labels cannot be changed. Click the **Cancel** button to clear the Create Results Log box from the work area without initializing a new log file.

   Entries to the log book are recorded as rows of information taken from the current cursor location for both vertical and horizontal cursors. When windows are linked, data are recorded first from the active window and then from the linked windows.

Setting Up a New Results Log

You can have up to eight fields in each log record. For each field, select the type of information that the field is to contain, and optionally assign a label to the field. You must also select a field separator.

When you first open the log book, all eight fields are blank. You can leave a field blank (field type NOTHING), or you can define it as one of the seven field types allowed, repeating a given field type as many times as you wish, and defining up to the limit of eight fields.

- Available field types are Time, D.Time, Amplitude, Energy, Frequency, D.Freq, and Pitch, as described below:
  - **Time** - Time value taken from the cursor location of a waveform, pitch, energy, spectrogram or formant history window.
  - **D.Time** - Time value describing the difference between the current data cursor location and the location of the data mark. Valid for waveform, pitch, energy, spectrogram or formant history windows.

- **Amplitude** - Vertical reading taken from a waveform window.
- **Energy** - Vertical reading taken from an energy, FFT power spectrum or LPC frequency response window.
- **Frequency** - Vertical reading taken from a spectrogram or formant history result window or the horizontal reading taken from an FFT power spectrum or LPC frequency response result window.
- **D.Freq** - Frequency value describing the difference between the current data cursor location and the location of the data mark (|). This value is a vertical reading when taken from a spectrogram or formant history results window or a horizontal reading when taken from an FFT power spectrum or LPC frequency response results window.
- **Pitch** - Vertical reading taken from a pitch result window.

1. To define a field type, do one of the following:
   - Click the Down Arrow box to display a drop box listing the available field types. Then select the desired field type from the displayed list.
   - Type the name of the field type in the box. When a field type is entered in this manner, you can use abbreviations to identify the field type, but sufficient information must be provided in the field name to distinguish field types from one another (i.e., **D.T** and **D.F**).
   - Using the keyboard, press the [Down Arrow] key to progress from one field type to the next.
2. Repeat Step 2 for each field that you wish to define, up to a maximum of eight (8) fields.

After the log fields have been assigned, you can enter a title for any or each of the log fields. Any text can be entered as a field label.

Choose how the log fields will be separated when the log file is saved to disk storage. The field separator can be a space, a tab, or a comma. Choose the **Tab** or **Comma** option to format the log book for access by a spreadsheet program. Select the **Space** option to save the log file so that the display is easily read when you send it to the printer or if you intend to edit it at a later date using any standard text editor.

6-8-3 Display the Current Entry

The current entry is the log record currently being built. The data it contains have not yet been saved to the log file.

At any time, you can verify the assigned log fields and view the current entry.

➢ Select **Display Current Entry** from the **Log** menu.

An information box is displayed showing the field labels, the field types, and any values stored in the fields of the current entry. Check marks in the New boxes to the right of the values indicates that these values are the most recent added to the record. There is a comment field in which you can enter textual information to be stored with the log record.

You can delete the new values in the current log entry:

1. Delete all values from all the fields in the current record, or write the current entry to the log book along with any textual information entered in the comment field.
2. If you add to or edit the information in the comment field, click **OK** to close the Building Log Entry box from the work area after first saving any changes made to the comment field. Click **Cancel** to clear the Building Log Entry box from the work area without saving any changes made to the comment field.

6-8-4 Display the Complete Contents of the Log File

To view all of the entries in the log book (not just the current entry):

- Select **Display All Entries** from the **Log** menu.

  Log entries are numbered on the immediate left of the log file. Line numbers are listed sequentially in the order that they are entered to the log, and the log entries are displayed in a scrollable dialog box.

6-8-5 Add Values to the Current Entry

1. Select **Enter Current Values** from the **Log** menu to record the information at the current cursor location to the appropriate log field(s). After adding, an information box displays the values stored in the current entry. This is the same information that is provided when you display the current entry. The most recent values added to the current entry are indicated by a check mark in the **New** box to the right of the log values.
2. From within the information box, you can click the **Save Now** button to write the current entry to the log book, even if all of the fields in the log entry are not full. Click the **Undo New** button to remove the values just recorded, or click the **Undo All** button to delete the values in all of the fields of the current log entry.

   Each time the current log entry is displayed, you are given the option to enter a comment which will be saved with the record. You can enter any textual information to identify the entry.
3. Click the **OK** button to accept the new or edited comment information and close the box. Click **Cancel** to close the information box without saving the revised comment information.

   Once all of the fields in the current record are filled, you must write the current entry to the log file or you must delete some or all of the values from the current record.
4. If you try to add values to the current log record and all of the log fields are full, an information box displays an error message. Click the **Save** button to write the current entry to the log file along with any textual information entered in the comment field. The new values are then recorded in the fields of the current entry and displayed in the usual manner. Click the **Clear** button to clear the values in all fields of the current entry before adding the new values. Click the **Cancel** button to cancel the operation.

6-8-6 Delete Values from the Current Entry

1. To clear the last added values from the fields for the current entry:
2. Select **Clear Last Values** from the **Log** menu.

   Only the fields filled by the last log add operation are removed from the log. These fields are identified by a check mark in the **New** box beside the values when viewed through the Build Log Entry dialog box. If the current log entry is displayed, you can click the **Undo New** button to perform this operation.
3. If the current log entry is displayed, you can click the **Undo All** button to clear all values from the current log entry.

6-8-7 Write the Current Entry to the Log Book

At any time, you can save the values in the fields of the current entry as a record in the log file. Note that you do not have to fill all the fields before saving the record. To write the current entry to the log book:

- Select **Save Current Entry** from the **Log** menu. If the current entry information box is displayed, you can optionally click the **Save Now** button.

  All values in the current entry are written to the log file, along with any information that has been entered into the comment field of the current entry. Each entry to the log book is recorded as a row of information, with the fields defining the columns in the log book.

6-8-8 Close the Current Log Book

1. Select **Close** from the **Log** menu to close the current log book.

   If current values have not been saved to the log book, a warning message is displayed and you are given the option to save them now.

2. Click **Yes** to save the current values and close the log. Click **No** to close the log without saving the values. Click **Cancel** to abort the request to close the log book.

   A message is displayed informing the user that the log book has been closed.

6-9 Options Menu

6-9-1 Analysis Options

Note that if the topmost analysis in the active window is the same type as the analysis options being modified (for example, if changing the pitch options when a pitch contour is the top plot in the active window), you can click the **Apply** button after changing the settings to apply the new settings to the active window. Click **OK** to close the dialog box and save the modified parameters in the current initialization file without applying the new settings to the active window. Click **Cancel** to close the dialog box and discard any changes that were made and not yet applied.

LPC Frequency Response Options

From the **Options** menu, select **Analysis**, then **LPC Frequency Response**. You can set the following LPC Analysis Options:

- **Frame Length** - Specifies the length of the frame of data to be analyzed when performing pitch-asynchronous analysis. During pitch-synchronous analysis, this variable is used for data in voiceless regions only, and the voiced regions are analyzed using a frame length determined by the voiced period marks.
- **Display Range (X-axis)** - Specifies the frequency range (X-axis) over which the frequency response will be displayed. You can choose to display the frequency range as a percentage of the Nyquist Frequency or as specific upper and lower frequency values.
- **Filter Order** - Selects the filter order, or the number of LPC coefficients to be applied to the analysis.
- **Pre-Emphasis** - Determines the application of pre-emphasis and the value of the pre-emphasis factor. A value of 0 means no pre-emphasis.

- **Display Range (Y-axis)** - Specifies the display range setting along the vertical axis in decibels of sound pressure level (dB SPL).
- **Analysis Method** - Selects the LPC analysis method. You have a choice of the autocorrelation or covariance methods.
- **Window Weighting** - Controls the application of window weighting to a frame of sampled data that is to be processed during LPC analysis. Window weighting is applied to reduce the amplitude of the signal as it approaches a frame boundary. If a rectangular window is selected, its effect is to apply no window weighting. Window weighting is recommended when using the autocorrelation method, and the rectangular window is recommended when the covariance method is applied.
- **Pitch-Synchronous** - Selects calculation of LPC framing from voiced period marks that are present in the data or from a fixed frame length.
- **Frequency Report** - specifies whether to report the x-axis value at the cursor location in Hz only, Hz and Bark, or Hz and Mel.

LPC Waterfall Options

From the **Options** menu, select **Analysis**, then **LPC Waterfall**. There are a number of LPCW analysis and display parameters that can be set by the user. The LPC Waterfall Setup box contains three (3) separate tabs. Click on the appropriate tab for the options you want to set, and then set the desired parameters.

LPCW Options: Analysis Tab

From the Analysis Tab, set the following LPCW options:

- **Analysis Method** - Specifies the LPC analysis method. Choices are the Autocorrelation method or the Covariance method.
- **Filter Order** - Specifies the filter order, or number of LPC coefficients to be applied to the analysis.
- **Pitch-Synchronous** - Specifies calculation of LPC framing from voiced period marks (voiced period marks) that are present in the data or from a fixed frame length. If pitch-synchronous analysis is selected and voiced period marks are in the source signal data, pitch-synchronous LPC values are computed; otherwise, fixed-frame LPC analysis is performed, with the size of the analysis frame determined by the setting for Frame Length.
- **Pre-Emphasis** - Determines the application of pre-emphasis and the pre-emphasis factor. If a value of 0 is entered, no pre-emphasis is applied.
- **Window Weighting** - Controls the application of window weighting to each frame of sampled data that is processed during LPC analysis. Window weighting is applied to reduce the amplitude of the signal as it approaches a frame boundary. If a rectangular window is selected, its effect is to apply no window weighting. A Blackman or Hamming window is recommended for speech processing.

LPCW Options: Framing Tab

From the Framing Tab, set the following LPCW options:

- **Frame Length** - Specifies the length of each frame of data to be analyzed when performing fixed frame (pitch-asynchronous) analysis. Frame length can be expressed in milliseconds or in number of sampled data points. During pitch-synchronous analysis, this variable is used for data in the voiceless regions only, and the voiced regions are analyzed using a frame length determined by the voiced period marks in the data.

- **Frame Advance** - Specifies the frame advance for fixed-frame LPC calculation. The frame advance can be expressed in milliseconds or in number of sampled data points. Frame advance is independent of frame length, so the analysis results can be for contiguous or overlapping frames, or can provide a small sample of LPC information for the data.

LPCW Options: Display Tab

From the Display Tab, set the following LPCW options:

- **Display Range (X-Axis)** - Specifies the frequency range (x-axis) over which the LPC frequency responses are displayed. The frequency range can be displayed as a percentage of the Nyquist Frequency or as specific upper and lower frequency values.
- **Display Range (Y-Axis)** - Controls the display range along the y-axis, in decibels of sound pressure (dB SPL).
- **Skew Angle** - Specifies the angle of the waterfall display to skew to the left or to the right. The window is divided into four quadrants of equal size. When set to skew right, the start frame is drawn in the bottom left quadrant and subsequent frames are drawn behind it and angled up and to the right. When set to skew left, the start frame is drawn in the bottom right quadrant and subsequent frames are drawn behind it and angled up and to the left.
- **Start Frame** - Specifies whether the first or last frame of the analysis results is plotted at the front of the waterfall array. Frames are plotted consecutively on the z-axis from first to last or from last to first, with the start frame plotted in the lower left or right quadrant of the window, depending on the setting for Skew Angle.

FFT Power Spectrum Options

From the **Options** menu, select **Analysis**, then **FFT Power Spectrum**. You can set the following FFT Analysis Options:

- **Analysis Size** - Specifies the number of coefficients in the FFT to be computed during analysis
- **Window Weighting** - Controls the application of window weighting to a frame of sampled data that is to be processed during FFT analysis. Window weighting is applied to reduce the amplitude of the signal as it approaches a frame boundary. If a rectangular window is selected, its effect is to apply no window weighting. A Blackman or Hamming window is recommended for speech processing.
- **Smoothing** - The power spectrum can be displayed in block mode or point mode, with a smoothing factor optionally applied to the spectral coefficients in point mode. Smoothing the energy in the frequency domain of the power spectrum is done in order to suppress any harmonic ripple present in the signal. The degree of smoothing to be applied depends upon the harmonic separation in the signal and upon the frequency resolution of the power spectrum.
- **Pre-Emphasis** - Determines the application of pre-emphasis and the value of the pre-emphasis factor. If a value of 0 is entered, no pre-emphasis is applied.
- **Frame Size** - Specifies the length of the frame of data to be analyzed. This can be equal to the number of FFT coefficients (analysis size), can be delineated by voiced period marks (pitch-synchronous), or can be another value expressed in number of sampled data points or in milliseconds. The frame size cannot be greater than the analysis size. If the selected frame size is less than the FFT analysis size, the frame is padded with zeros.
- **Display Range (X-Axis)** - Specifies the frequency range (X-axis) over which the power spectrum will be displayed. You can choose to display the frequency range as a percentage of the Nyquist Frequency or as specific upper and lower frequency values.

- **Display Range (Y-Axis)** - Controls the display range setting along the Y-axis, in decibels of sound pressure (dB SPL). If normalization is on, this parameter is ignored.
- **Frequency Report** - specifies whether to report the x-axis value at the cursor location in Hz only, Hz and Bark, or Hz and Mel.

FFT Waterfall Options

From the **Options** menu, select **Analysis**, then **FFT Waterfall**. There are a number of FFTW analysis and display parameters that can be set by the user. Note that the FFT Waterfall Setup box contains three (3) separate tabs. Click on the appropriate tab for the options you want to set, and then set the desired parameters.

FFTW Options: Analysis Tab

From the Analysis Tab, set the following FFTW options:

- **FFT Analysis Size** - Specifies the number of coefficients in the FFT to be computed during analysis. The FFT Analysis Size must be greater than or equal to the Frame Length.
- **Pre-Emphasis** - Determines the application of pre-emphasis and the pre-emphasis factor. If a value of 0 is entered, no pre-emphasis is applied.
- **Smoothing Level** - The power spectra in the waterfall array can be displayed in Block Mode or Point Mode, with a smoothing factor optionally applied to the spectral coefficients in Point Mode. Smoothing the energy in the frequency domain of a power spectrum is done in order to suppress any harmonic ripple present in the signal. The degree of smoothing to be applied depends on the harmonic separation in the signal and on the frequency resolution of the power spectrum.
- **Window Weighting** - Controls the application of window weighting to each frame of sampled data that is processed during FFT analysis. Window weighting is applied to reduce the amplitude of the signal as it approaches a frame boundary. If a rectangular window is selected, its effect is to apply no window weighting. A Blackman or Hamming window is recommended for speech processing.

FFTW Options: Framing Tab

From the Framing Tab, set the following FFTW options:

- **Frame Advance** - Specifies the frame advance for fixed-frame FFT calculation. The frame advance can be equal to the number of coefficients in the FFT, or can be specified as a value expressed in number of sampled data points or in milliseconds. Frame advance is independent of frame length, so the analysis results can be for contiguous or overlapping frames, or can provide a small sample of FFT information for the data.
- **Frame Length** - Specifies the length of each frame of data to be analyzed. Frame length can be equal to the number of FFT coefficients (FFT Analysis Size), can be delineated by voiced period marks in the sampled data (Pitch-Synchronous), or can be another value expressed in number of sampled data points or in milliseconds. The frame length cannot be greater than the FFT analysis size. If the selected frame length is less than the FFT analysis size, the frame is padded with zeros.

FFTW Options: Display Tab

From the Display Tab, set the following FFTW options:

- **Display Range (X-Axis)** - Specifies the frequency range (x-axis) over which the power spectra are displayed. The frequency range can be displayed as a percentage of the Nyquist Frequency or as specific upper and lower frequency values.
- **Display Range (Y-Axis)** - Controls the display range along the y-axis, in decibels of sound pressure (dB SPL).

- **Skew Angle** - Specifies the angle of the waterfall display to skew to the left or to the right. The window is divided into four quadrants of equal size. When set to skew right, the start frame is drawn in the bottom left quadrant and subsequent frames are drawn behind it and angled up and to the right. When set to skew left, the start frame is drawn in the bottom right quadrant and subsequent frames are drawn behind it and angled up and to the left.
- **Start Frame** - Specifies whether the first or last frame of the analysis results is plotted at the front of the waterfall array. Frames are plotted consecutively on the z-axis from first to last or from last to first, with the start frame plotted in the lower left or right quadrant of the window, depending on the setting for Skew Angle.

LTA Power Spectrum Options

From the **Options** menu, select **Analysis**, then **LTA Power Spectrum**. You can set the following LTA Analysis Options:

- **Analysis Size** - Specifies the length of the frame of data to be analyzed, in number of sampled data points.
- **Display Range (X-Axis)** - Specifies the frequency range (X-Axis) over which the power spectrum will be displayed. You can choose to display the frequency range as a percentage of the Nyquist Frequency or as specific upper and lower frequency values.
- **Display Range (Y-Axis)** - Controls the display range setting along the Y-axis, in decibels of sound pressure (dB SPL). If normalization is on, this parameter is ignored.
- **Pre-Emphasis** - Determines the application of pre-emphasis and the value of the pre-emphasis factor. A value of 0 means no pre-emphasis is applied.
- **Smoothing** - The power spectrum can be displayed in BLOCK mode or POINT mode, with a smoothing factor optionally applied to the spectral coefficients in point mode. Smoothing the energy in values in the frequency domain of the power spectrum is done in order to suppress the harmonic ripple present in the signal. The degree of smoothing to be applied depends upon the harmonic separation in the signal and upon the frequency resolution of the LTA power spectrum.
- **Window Weighting** - Controls the application of window weighting to a frame of sampled data that is to be processed. Window weighting is applied to reduce the amplitude of the signal as it approaches a frame boundary. If a rectangular window is selected, its effect is to apply no window weighting. A Blackman or Hamming window is recommended for speech processing.

Cepstrum Analysis Options

From the **Options** menu, select **Analysis**, then **Cepstrum Analysis**. You can set the following Cepstrum Options:

- **Time** - Sets the time domain of the quefrency axis (X-Axis) over which the cepstrum will be displayed. The time display range is in milliseconds. Select the **Display All Data** checkbox to display all of the data, or clear the checkbox and enter values in the **Minimum** and **Maximum** edit boxes to display a smaller specified range. Recommended time values are 0.1 and 12.0. When normalization is applied to this display, it is normalized to the maximum and minimum values found within this range.
- **Level** - Sets the amplitude display range (Y-Axis) for the cepstrum display. If normalization is turned on, the parameter is ignored.

Spectrogram Options

From the **Options** menu, select **Analysis**, then **Spectrogram**. There are a number of Spectrogram analysis and display parameters that can be set by the user. The Spectrogram Analysis Configuration box contains three (3) separate tabs. Click on the appropriate tab for the options you want to set, and then set the desired parameters.

SPG Options: Analysis Tab

From the Analysis tab, you can set the following Spectrogram Options:

- **Analysis Size** - Specifies the number of sampled data points per frame that are to be applied to the spectrogram. The number of data points translates to a spectrogram "bandwidth", which is interpreted by the program from the frame length and the sampling rate of the data in the source window.
- If the source window contains signal data, a Hertz value is reported in the **Analysis Size** box beside each points value, along with a message that the displayed bandwidths are for analysis of the current default source.
- **Pre-Emphasis** - Determines the application of pre-emphasis and the value of the pre-emphasis factor. A value of 0 means no pre-emphasis is applied.
- **Window Weighting** - Controls the application of window weighting to a frame of sampled data that is to be processed during SPG analysis. Window weighting is applied to reduce the amplitude of the signal as it approaches a frame boundary. If a rectangular window is selected, its effect is to apply no window weighting. A Blackman or Hamming window is recommended for speech processing.

SPG Options: Display Tab

From the Display tab, you can set the following Spectrogram Options:

- **Display** - Specifies the frequency range over which the spectrogram will be displayed. You can choose to display the frequency range as a percentage of the Nyquist Frequency or as specific upper and lower frequency values. The recommended maximum frequency is 40% of the sampling rate.
- **Frequency Display** - Specifies whether the display of the spectrogram will be shown in a logarithmic scale, linear scale, Bark scale or Mel scale.

SPG Options: Palette Tab

From the Palette tab, you can set the following Spectrogram Options:

- **Palette** - Selects one of the preset color palettes to be used to display the spectrogram.
- **Scale** - Displays the decibel range assigned to evenly distributed gray shades or colors used to plot the relative levels of energy in the spectrogram. You can change any of these values. Alternatively, enter a minimum and maximum decibel level, and click the **Smooth** button (to the right) to create a linear relationship to the values assigned to the interceding shades. Use the scrollbar to raise or lower the overall color scale-to-gain assignment, to brighten or darken the display.
- **Scale Adjustment** - Specifies an adjustment in decibels of sound pressure (dB SPL) that is applied to the color scale of the spectrogram, to lighten or darken the color scale.

Formant History Options

From the **Options** menu, select **Analysis**, then **Formant History**. There are a number of FMT analysis and display parameters that can be set by the user. Note that the Formant Analysis Configuration box contains four (4) separate tabs. Click on the appropriate tab for the options you want to set, and then set the desired parameters.

FMT Options: Analysis Tab

From the Analysis Tab, set the following FMT options:

- **Filter Order** - Selects the filter order, or the number of LPC coefficients, to be applied to each LPC analysis frame.
- **Pre-Emphasis** - Determines the application of pre-emphasis and the value of the pre-emphasis factor. A value of 0 means that no pre-emphasis is applied.
- **Analysis Method** - Selects the LPC analysis method. You have a choice of the autocorrelation or covariance methods.
- **Window Weighting** - Controls the application of window weighting to a frame of sampled data that is to be processed during FMT analysis. Window weighting is applied to reduce the amplitude of the signal as it approaches a frame boundary. If a rectangular window is selected, its effect is to apply no window weighting. Window weighting is recommended when using the autocorrelation method, and the rectangular window is recommended when the covariance method is applied.

FMT Options: Framing Tab

From the Framing Tab, set the following FMT options:

- **Pitch-Synchronous (Use Voiced Period Marks)** - Selects calculation of formant history framing from voiced period marks that are present in the data or from a fixed frame length.
- **Unvoiced Frame Size** - Specifies the length of the frame of data to be analyzed when performing fixed frame analysis. During pitch-synchronous analysis, this variable is used for data in voiceless regions only, and the voiced regions are analyzed using a frame length determined by the voiced period marks.
- **Frame Advance** - Selects the time, in milliseconds, by which the analysis frame is advanced during fixed frame analysis. Frame advance is independent of the frame length, so the FMT analysis results can be for contiguous or overlapping frames, or can provide a small sample of FMT information for the data. This option is disabled during pitch-synchronous analysis (i.e., **Use Voiced Period Marks** is selected).

FMT Options: Display Tab

From the Display Tab, set the following FMT options:

- **Display Range** - Specifies the frequency range over which the formant history will be displayed. You can choose to display the frequency range as a percentage of the Nyquist Frequency or as specific upper and lower frequency values.
- **Bandwidth Limit** - Specifies whether to display all formants, or whether to set a threshold value of the bandwidth, so that formants above the threshold are not included in the graphic display, and are optionally excluded from the reported numerical results.
- **Energy Limit** - Specifies whether to display all formants, or whether to turn off LPC analysis in frames whose signal energy is less than the set threshold value, so that formants in analysis frames with energy below the set threshold are not included in the graphic display, and are optionally excluded from the reported numerical results.

- **Only Voiced** - Specifies whether to display all formants, or whether to turn off LPC analysis in frames that are voiceless.
- **Show Bandwidth** - Specifies whether to display the bandwidth with each reported formant frequency so that the length of the vertical line represents the bandwidth of the formant, or whether to display the formant contours as a series of dots.
- **Frequency Display** - Specifies whether the display of the formant history will be shown in a logarithmic scale, linear scale, Bark scale, or Mel scale.

FMT Options: Color Tab

From the Color Tab, set the following FMT options:

- **Use Large Dots** - Specify whether to display the formant history plot using large dots or small dots.
- **Contour Colors** - Specify the colors to display the formant contours. For improved observation and editing purposes, a different color can be assigned to each formant. Alternatively, all formants can be displayed using the window pen color.

Voiced Period Marks (Impulse) Options

From the **Options** menu, select **Analysis**, then **Voiced Period Marks**. You can set the following Impulse Analysis Options:

- **Analysis Range** - Specifies the analysis range setting in Hertz. A narrower range can be set to selectively examine a particular region of the signal, while a wide analysis range (for example, 50 to 1000 Hz) can be used successfully for most speech. Reducing the range can help to avoid erroneous selection of harmonic periods in low-frequency signals.
- **Location** - Governs the location where the voiced period marks are placed during analysis. If Peak is selected, impulse marks are placed at the dominant amplitude peak at the start of each voiced period. This could be a negative or a positive peak depending upon the polarity of the signal. If Zero Crossing is selected, impulse marks are placed at the zero crossing immediately preceding the dominant amplitude peak at the start of each voiced period.
- **Zero Offset** - Specifies the zero offset in amplitude to compensate for any DC float that can have been produced by the hardware. If the signal offset has been previously computed, the resulting value is automatically used.

Pitch Contour Options

From the **Options** menu, select **Analysis**, then **Pitch Contour**. There are a number of Pitch analysis and display parameters that can be set by the user. The Pitch Analysis box contains three (3) separate tabs. Click on the appropriate tab for the options you want to set, and then set the desired parameters.

Pitch Options: Analysis Tab

From the Analysis tab, you can set the following Pitch Options:

- **Pitch Synchronous Analysis** - Specifies pitch synchronous (from impulse marks) or pitch asynchronous (i.e., fixed frame) analysis. If this checkbox is selected and impulse marks are not in the signal data, the pitch synchronous analysis process will compute impulse locations and store them internally. If this checkbox is selected and impulse marks are in the signal, then the impulse locations in the signal are used. If this checkbox is clear (unselected), fixed frame analysis is performed using the frame length and frame advance settings specified on the Framing tab. Interpolation is applied to the pitch analysis results (pitch synchronous or fixed frame) in order to improve the resolution of the pitch analysis process.

- **Impulse Location** – Specifies the location of the impulse marks computed during pitch synchronous analysis. Options are at the dominant amplitude peak (which can be negative or positive, depending on the polarity of the signal) at the start of each voiced period, or at the zero crossing immediately preceding the dominant amplitude peak at the start of each voiced period. Note that this option is disabled if the **Pitch Synchronous Analysis** checkbox is clear (unselected). If Pitch Synchronous Analysis is selected and impulse marks are already in the signal, this setting is ignored.
- **Analysis Range** - Specifies the analysis range setting in frequency (Hertz) for accepting fundamental frequency (pitch) analysis results. To avoid possible error, the analysis range should be close to the expected fundamental frequency range.
- **Process High Frequency Signal** – Specifies analysis of a high-frequency signal. Use this setting to obtain better results when analyzing some signals from a female or child's voice. Note that this option is disabled if the **Pitch Synchronous Analysis** checkbox is selected.
- **Pitch Sensitivity** – Specifies the sensitivity of the pitch analysis routine. If the pitch analysis does not produce pitch values in expected locations (giving drop-outs in the analysis), increase the pitch sensitivity. If the pitch analysis is detecting more pitch values than expected (giving spurious values in the analysis), decrease the pitch sensitivity. Note that this option is disabled if the **Pitch Synchronous Analysis** checkbox is selected.
- **Smoothing Level** - Optionally smooths the pitch contour by replacing the un-smoothed pitch results with new values that are computed by applying median smoothing to the voiced frames that are located within a specified time interval that is centered around the start of the current frame. The duration of the time interval is 50 msec if a **Low** level of smoothing is selected, 100 msec for **Medium**, and 200 msec for **High**. The number of adjacent frames that is used to smooth each frame consists of all frames that lie completely within the time interval that corresponds to the smoothing level selected. Select **None** to display the un-smoothed pitch results. Note that the **Low** radio button is disabled if either the Frame Length or Frame Advance setting is greater than 25 msec.

Pitch Options: Framing Tab

From the Framing tab, you can set the following Pitch Options:

- **Frame Length** - During fixed frame (or pitch-asynchronous) analysis, specifies the length of a frame of waveform data used for computing the fundamental frequency (pitch). Note that this option is disabled if the **Pitch Synchronous Analysis** checkbox is selected on the Analysis tab.
- **Frame Advance** - Selects the time, in milliseconds, by which the analysis frame is advanced during fixed frame analysis. Frame advance is independent of frame length, so the pitch analysis results can be for contiguous or overlapping frames, or can provide a small sample of pitch information for the data. The smaller the frame advance is, the more detail about the pitch characteristics becomes available. Note that this option is disabled if the **Pitch Synchronous Analysis** checkbox is selected on the Analysis tab.

Pitch Options: Display Tab

From the Display tab, you can set the following Pitch Options:

- **Display Range** - Specifies the display range in frequency (Hertz) for the display of a pitch contour. Note that the display range is set separately for pitch contours displayed on a logarithmic frequency scale or a linear frequency scale. If normalization is on, this parameter is ignored.
- **Draw Dot Contour** - Selects display of the pitch plot as a series of dots or as a solid line.
- **Use Large Dots** - If a dot contour display is selected, specifies whether to display the pitch contour using large dots or small dots.
- **Frequency Scale** - Selects display of the pitch contour on a logarithmic or linear frequency scale.

Energy Contour Options

From the **Options** menu, select **Analysis**, then **Energy Contour**. You can set the following Energy Options:

- **Frame Length** - Specifies the length of a frame of a data used for energy calculation. This parameter specifies the frame length in voiceless regions only if pitch-synchronous analysis is used.
- **Frame Advance** - Selects the time, in milliseconds, by which the analysis frame is advanced. Frame advance is independent of the frame length, so the energy analysis results can be for contiguous or overlapping frames, or can provide a small sample of energy information for the data. This parameter is ignored during pitch-synchronous analysis.
- **Pitch-Synchronous** - Selects calculation of energy frames from voiced period marks that are present in the data (pitch-synchronous) or from a set frame length.
- **Draw Dot Contour** - Selects display of the energy plot as a series of dots or as a solid line.
- **Use Large Dots** – If a dot contour display is selected, specifies whether to display the energy contour using large dots or small dots.
- **Smoothing Level** - You can optionally apply smoothing to the computed energy values across adjacent frames.
- **Display Range** - Specifies the display range in decibels of sound pressure (dB SPL) for the display of the energy contour. If normalization is on, this parameter is ignored. Note that the display range is automatically adjusted by the energy shift value if the **Energy Shift** checkbox is selected.
- **Energy Shift** - Specifies whether to shift the calculated energy values by a set shift value, to adjust the dB values to approximate real-world dB SPL. If the **Energy Shift** checkbox is selected, the shift value can be entered in the associated edit box.

6-9-2 Edit Options

Signal Offset Options

From the **Options** menu, select **Editing**, then **Signal Offset**. You can set the following offset parameters:

- **Automatic vs. Manual** - Specifies whether the offset value be computed automatically and applied to the signal data, or whether a manually set offset value be applied to the signal data.
- **DC Offset Value** - Specifies the DC offset if a manually set offset value is to be applied to the signal data.

Copy Options

From the **Options** menu, select **Editing**, then **Copy**. You can set the following Copy Options:

- **Channels** - If the signal is multi-channel, you can select which channel(s) of the data to copy. Options are to copy only the displayed channel, to copy all channels, or to copy selected channels from the source waveform to the active window.
- **Copy As** - If copying only the displayed channel, you can select which channel in the active window to copy the data to.
- **Signal Attributes** - You can select which attributes of the signal you would like to include with the copied data. If the following attributes are present in the source data, they can be copied along with the waveform signal: Impulse marks (voiced period marks), IPA transcription, Tags, or Palatometer Images. A check mark appears in the box beside the attribute description if that signal information will be copied along with the waveform data.

Append Options

From the **Options** menu, select **Editing**, then **Append**. You can set the following Append Options:

- **Signal Attributes** - You can select which attributes of the data you would like to include with the appended data. If the following attributes are present in the data, they can be appended with the data: Impulse marks (voiced period marks), IPA transcription, Tags or Palatometer Images. A check mark appears in the box beside the attribute description if that signal information will be appended with the waveform data.
- **Channels** - If the signal is multi-channel, you can append all channels of data or just the displayed channel.

Insert Options

From the **Options** menu, select **Editing**, then **Insert**. You can set the following Insert Options:

- **Signal Attributes** - You can select which attributes of the data you would like to include with the inserted data. If the following attributes are present in the data, they can be inserted with the data: Impulse marks (voiced period marks), IPA transcription, Tags or Palatometer Images. A check mark appears in the box beside the attribute description if that signal information will be inserted with the waveform data.
- **Channels** - If the signal is multi-channel, you can insert all channels of data or just the displayed channel.

Mix Options

From the **Options** menu, select **Editing**, then **Mix**. You can set the following Mix Options:

- **Perform Signal Averaging** - A check mark in the **Perform Signal Averaging** box indicates that waveforms will be mixed by averaging the waveform amplitude values. Clear this box to mix the waveforms by adding the waveform amplitude values. Values that cause overflow are clipped to the maximum amplitude value of 32767, and are displayed in red.

Filter Options

From the **Options** menu, select **Editing**, and then **Filter**. You can set the following Filter Options:

- **Filter Order** - Sets the filter order, or number of poles that are applied to the filter, between a minimum of 4 and a maximum of 250. The higher the order, the steeper the cutoff of the filter. For a band-pass or band-reject filter, the number of poles selected is divided evenly between the low and high cutoffs.
- **Filter Type** - Can be Low Pass, High Pass, Band Pass or Band Reject.
  - A low-pass filter attenuates any energy in the signal that is above a set frequency.
  - A high-pass filter attenuates any energy in the signal that is below a set frequency.
  - A band-pass filter attenuates any energy in the signal that is outside the set lower and upper frequency cutoffs.
  - A band-reject filter attenuates any energy in the signal that is inside the set lower and upper frequency cutoffs.
- **Window Type** - Can be Rectangular, Triangular, Hamming, Blackman, or Hanning. For speech signals, it is advised that a Blackman or a Hamming window be used.
- **Cutoffs** - Cutoffs are relative to the Nyquist frequency, which is half the sampling rate. To determine a cutoff percentage, use the formula:

  cutoff %= (Shoulder Frequency / Nyquist Frequency) * 100%

  For example, to set a low-pass filter at 2000 Hertz in a signal sampled at 10000 samples per second, the cutoff would be 40%.

Source Signal Duration Options

From the **Options** menu, select **Editing**, then **Source Signal Duration**. You can set the following Rate Synthesis Options:

- **Rate Modification** - Specifies the percentage change in the duration from the original. The duration can be decreased to a minimum of 30% of the original data duration, or increased to 300% or 3 times the original duration. A setting of 100% has the effect of making no change to the duration of the data.
- **Processing Options** - Specifies whether to generate audio output of the time-modified signal data, or whether to generate a new signal from the modified data, displaying the waveform in the empty active window.

- **Horizontal Axis Divisions per Interval**: Specifies the number of divisions within each major grid interval on the horizontal axis. If **Grid Layout by Data Type** is not selected, this setting is ignored. Note that horizontal grid lines are not displayed unless the **Grid on Horizontal Axis** checkbox is selected.
- **Horizontal Axis Show Grid Labels**: Specifies display of grid labels at each major grid interval on the vertical axis. If not selected, labels are displayed only at the extreme edges of the display area. If **Grid Layout by Data Type** is not selected, this setting is ignored. Note that horizontal grid lines are not displayed unless the **Grid on Horizontal Axis** checkbox is selected.
- **Horizontal Axis Mark Intervals with Lines**: Specifies whether major grid intervals on the horizontal axis are displayed as lines across the window or as tick marks. If **Grid Layout by Data Type** is not selected, this setting is ignored. Note that horizontal grid lines are not displayed unless the **Grid on Horizontal Axis** checkbox is selected.
- **Vertical Axis Grid Interval**: Specifies placement of major grid lines on the vertical axis (i.e., horizontal lines). If **Grid Layout by Data Type** is not selected, this setting is ignored. Note that vertical grid lines are not displayed unless the **Grid on Vertical Axis** checkbox is selected. If the set grid interval will cause the labels to overlap, fewer labels are used.
- **Vertical Axis Divisions per Interval**: Specifies the number of divisions within each major grid interval on the vertical axis. If **Grid Layout by Data Type** is not selected, this setting is ignored. Note that vertical grid lines are not displayed unless the **Grid on Vertical Axis** checkbox is selected.
- **Vertical Axis Show Grid Labels**: Specifies display of grid labels at each major grid interval on the vertical axis. If not selected, labels are displayed only at the extreme edges of the display area. If **Grid Layout by Data Type** is not selected, this setting is ignored. Note that vertical grid lines are not displayed unless the **Grid on Vertical Axis** checkbox is selected.
- **Vertical Axis Mark Intervals with Lines**: Specifies whether major grid intervals on the vertical axis are displayed as lines across the window or as tick marks. If **Grid Layout by Data Type** is not selected, this setting is ignored. Note that vertical grid lines are not displayed unless the **Grid on Vertical Axis** checkbox is selected.

7 Windows and Work Area

CSL and Multi-Speech can have up to 26 windows open at once, titled in alphabetical order from A to Z. This section details source and active windows, linking and unlinking windows, and options customizations.

7-1-1 Open New Window

You can create and display up to 26 windows at a time in the work area. The window labels are in alphabetical order, from A to Z.

Open a new window:

1. To open a new window based on the active window, choose **Open New Window** from the **Window** menu.

   A new window is created and activated over the previously active window. The size of the new window is the same as the previously active window. The new window will also have the same display settings. If no windows were displayed in the work area prior to executing this command, the settings for window size, position and attributes are taken from an initialization file.

   A scrollbar can optionally be displayed in the window. This scrollbar represents the full range of data in the window. A red indicator above the scrollbar shows the location of the data cursor in the window, a green indicator shows the location of the data mark, and two blue indicators show the locations of the selection marks in the data.
2. Position the mouse arrow over the window title bar and, holding the Left mouse button down, drag the window to the desired location in the work area. Use the mouse arrow and **Left** mouse button to change the size of the window.

7-1-2 Open Preset Window

1. From the **Window** menu, choose **Open Preset Windows**.
2. Select one of the following options to create and activate a new window which is the appropriate size for the selected type of data:

   For Waveforms etc.
   For Spectrograms etc.
   For Analysis Contours etc.
   For Frequency Response etc.
3. You can resize the window if desired, and drag it to a convenient location within the work area. To move the window, position the mouse arrow over the window title bar, then hold the **Left** mouse button down while dragging the window to the desired location in the work area.
4. You can also change the window attributes, such as the color to display graphics within the window and the placement of grid lines in the window.

7-1-3 Closing Windows

If you find that your work area is becoming cluttered, you can want to close one or more of the windows that are currently displayed. Note that when you close a window, any data associated with the window is lost.

1. To close the active window, choose **Close Active Window** from the **Window** menu.

   The active window is removed and the next window in the list becomes the active window.

2. To close all of the open windows, select **Close All Windows** from the **Window** menu.

7-1-4 Clear (Purge) Window Contents

You can clear the contents of a window, creating an empty window, ready to display new waveform or analysis data.

To clear the active window:

➢ From the **Window** menu, choose **Purge Active Window**.

The data in the active window is deleted. Note that if the data in a linked window are purged, that window is automatically removed from the link list.

7-1-5 Make a Window Active

Many program operations use the currently active window. For example, when loading a sampled data file, the program loads the signal to the active window. Up to 26 windows, labeled **A** through **Z**, can be open at one time. You can select which window is active in a number of ways, as described below. Note that when you create (open) a new window, it automatically becomes the active window. A window must already exist in the work area before it can be activated.

To activate the next or previous window in alphabetical order

➢ Choose **Activate Next Window** or **Activate Previous Window** from the **Window** menu. Windows that are minimized cannot be accessed using this method.

To activate any existing window (not necessarily the next or previous window in alphabetical order),

➢ Click the **Left** mouse button on the title bar of any window displayed in the work area to activate it. To activate a minimized window, simply restore it.

7-1-6 Link and Unlink Windows

You can link cursor movement, data mark movement, selection area definition, and data display operations in the active window with another window containing compatible data. Note that if the data in a linked window are purged, that window is automatically removed from the link list.

To link windows:

1. Ensure that the data in the windows you wish to link have the same horizontal dimension. The windows need not be the same duration, however. (If the durations are different and the windows are linked, you can use the show operation to align the linked waveforms.)
2. To link the active window to the default source window, choose **Link Windows**, **Link to Source Window** from the **Window** menu.
3. You can activate a different window, and then repeat Step 2 to link operations in more than two windows.

4. Move the cursor around in one of the linked windows and note how cursor movement is duplicated in the other linked windows. Select a region of data in a linked window and display the selected data. The selection area is redisplayed in all linked windows.

To unlink the active window in the link list:

➢ Select **Link Windows**, **Unlink Active Window** from the **Window** menu.

To display a list of linked windows:

➢ Select **Link Windows**, **Show Current Links** from the **Window** menu. A list of the windows that are currently linked to the active window is displayed.

7-1-7 **Multi-Channel Windows**

Note that the program supports the display of more than one channel of data in the window. Optionally, a single channel of the signal can be displayed in the window at any given time, or all channels can be displayed.

Here is a display of a window containing multi-channel signal data with all channels displayed.

Note It is rare in clinical applications to use more than two channels, but CSL and Multi-Speech support up to eight.

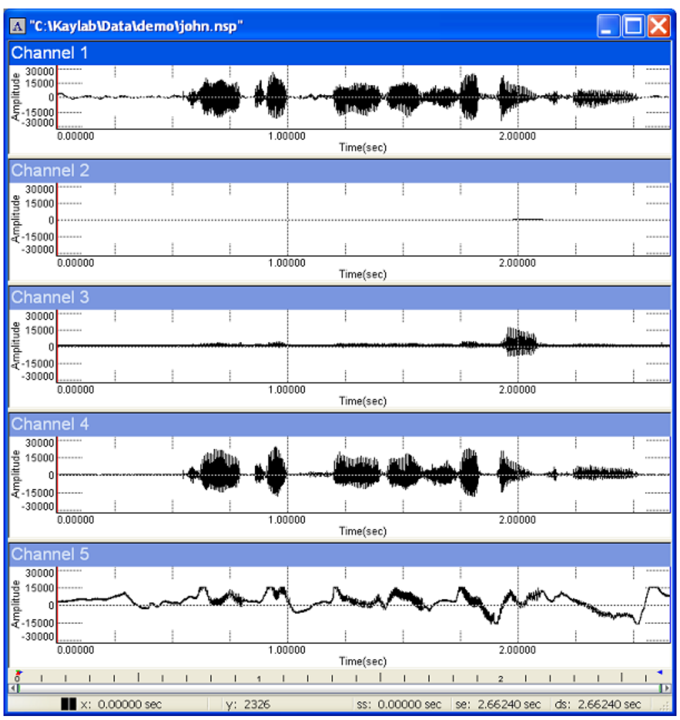

Figure 25. Active window with multi-channel signal data.

The loaded signal file contains five channels of data and is divided into a pane for each channel. The title bar for the Channel 1 pane is highlighted, indicating that Channel 1 is the currently active channel. Click on the title of a different pane to activate a different channel

7-1-8 Select Source Window

When waveform data are loaded, generated, or captured to a window, that window automatically becomes the default source window. The current default source window is reported in a box in the lower right-hand corner of the work area. Many of the data analysis and data editing commands are performed on the waveform in this default source window.

If more than one window containing waveform data is displayed, you can want to analyze a signal that was obtained earlier than the current default source signal. You must change the default source before the operation takes place.

To select the Active window as the default Source:

- Activate the window containing the waveform data you wish to use as the source data for analysis, and then choose **Select Active Window as Source** from the **Window** menu.

7-1-9 Display Information about Window Contents

You can display an information box containing the summary information for the waveform data or results data in the specified window.

Note that if the active window contains waveform data, the information box will inform you if IPA Transcripts, Voiced Impulse Marks (voiced period marks); Tags, and/or Palatogram information have been added to the displayed channel of the signal. These types of information, though stored with the waveform, are not always displayed in the window. Select **Waveform** from the **Options** menu to display a dialog box in which you can select the signal attributes to display or hide.

To display information on the active window:

1. Activate the window that you want information on, and then choose **Information on Active Window** from the **Window** menu.

   If the active window contains waveform data, summary information is displayed for the current channel of data in the window. If the data is multi-channel, you can click the radio button for a different channel of data to display summary information for that signal data. If you wish, you can add to or change the comment in the **Comment Field** of the Information box. This textual information is stored with the waveform data when the file is saved in CSL signal file format (NSP), but will be lost if the data are saved in any other audio file format.

   If the active window contains analysis results data, the information box will display the type of analysis, information identifying the source window for the analysis data, and the analysis parameter settings. For all analysis data except transient data, the box contains a **Comment Field** for entry of textual information.

2. An **Apply** button is present in the Spectrogram Analysis Information box. You can change the display settings from the Palette tab of the summary information box, and then apply the change to the spectrogram display in the active window. For example, you can change the color palette or change the decibel values assigned to the gray shades or colors used to plot the relative levels of energy in the spectrogram.

3. Choose the **OK** button, remove the information box from the work area, and save any changes made. Choose **Cancel** to close the information box without saving any changes.

7-1-10 Window Features

CSL and Multi-Speech are extremely versatile programs, and you can customize much about what and how each window is displayed.

To change window options:

1. Click inside the window you want to change options in, making sure it is listed as the Active Window in the bottom right of the application.
2. At the **Options** menu, select **Window Attributes**. You can set the following Window Display Options:
   - **Normalize** - Governs application of normalization to non-transient data. If normalization is applied, graphics are drawn with the maximum and minimum y-axis values defining the display range.
   - **Show Grid** - Overlays horizontal and/or vertical grid lines across the window. Click the **Grid Options** button to display a Grid Layout box in which you can fine-tune the display of the grid.
   - **Display Scrollbar** - Displays a scrollbar under the horizontal axis of the active window. If a scrollbar is displayed in the window, the window can be set to update the graphic display during scrolling or after scrolling.
   - **Pen Color** - Selects the color to draw graphics. Also provides the ability to optionally define a new pen color, and add it to the list of available pen colors.

   Double-clicking on the Active (leftmost) or Next (rightmost) pen color indicator in the window status line to display a box of color swatches, and then selecting a new color from the displayed box.

Grid Layout Options

If the **Show Grid** checkbox is selected in the Windows Options box, grid lines are overlaid on top of the graphics display in the window. From the Window Options box, click the **Grid Options** button to display a Grid Layout box, in which you can fine-tune the grid overlay.

- **Grid on Horizontal Axis**: Overlays grid lines across the window on the horizontal axis (vertical lines). Grid lines can be placed automatically by the program, or placed manually at specified intervals if the **Grid Layout by Data Type** checkbox is selected.
- **Grid on Vertical Axis**: Overlays grid lines across the window on the vertical axis (horizontal lines). Grid lines can be placed automatically by the program, or placed manually at specified intervals if the **Grid Layout by Data Type** checkbox is selected.
- **Grid Color**: Selects the color of the grid lines.
- **Grid Layout by Data Type**: Specifies whether grid lines are placed automatically by the program (i.e., the checkbox is clear) or placed manually at user-specified intervals based on the type of data in the window (i.e., the checkbox is selected). If manual placement is selected, optionally define major grid intervals, number of divisions within each grid interval, display of grid labels, and display of the major grid as lines across the window or as tick marks. Note that grid lines are only displayed if the **Grid on Horizontal Axis** and/or **Grid on Vertical Axis** checkbox is selected, regardless of whether they are placed manually or automatically.

- **Data Type**: Lists the types of data that can exist in a window, e.g., signal data or analysis results data. Grid placement for each data type can be defined separately if the **Grid Layout by Data Type** checkbox is selected.
- **Horizontal Axis Grid Interval**: Specifies placement of major grid lines on the horizontal axis (i.e., vertical lines). If **Grid Layout by Data Type** is not selected, this setting is ignored. Note that horizontal grid lines are not displayed unless the **Grid on Horizontal Axis** checkbox is selected. If the set grid interval will cause the labels to overlap, fewer labels are automatically used.

7-1-11 **Work Area Layout**

Routines are provided which allow you to open and close windows in the work area. Commands also exist for cascading and tiling the existing windows in the work area.

You can rearrange the windows in the work area so that they are cascaded or tiled. This does not affect any data in the windows. Minimized windows remain minimized.

To rearrange the windows in the work area:

- To overlap (cascade) the windows with the active window in front and the title bar for each window is visible, select **Cascade** from the **Window** menu.
- To redraw the windows with similar sizes so they all are fully displayed in the work area, do one of the following:
- To rearrange the windows into horizontal tiles, select **Tile Horizontally** from the **Window** menu.
- To arrange the windows into vertical tiles, select **Tile Vertically** from the **Window** menu.

7-1-12 Minimize, Maximize and Restore Windows

Windows can be minimized, maximized and restored in the work area in the same manner that application windows can be minimized, maximized, and restored within Windows. Maximize a window to better display the data. Shrink a window to an icon when you finish working with the data in it, but want it available for later use. The data are still held in memory, but the window is not taking up space in the work area.

To maximize a window:

- Click the **Maximize** button in the upper right-hand corner of a window to fill the work area with the contents of the window.

To minimize a window:

- Click the **Minimize** button in the upper right-hand corner of a window to shrink the window to an icon. Each icon includes a title which identifies both the window label and contents. If the icon represents a window containing multiple analysis plots, the topmost plot is identified.

To restore a window:

- To restore the window, access the **Window** menu, and then click on the window title at the bottom of the menu. This will both restore a minimized window and activate it. The window is restored in the work area to its original size and placement.

7-1-13 Window Display Settings

You can change the window display settings for the active window, such as the pen color and the placement of grid lines in the window. Changing the pen color is a particularly useful feature if, for example, the results of more than one analysis are to be overlaid in a window.

To set the window options:

1. To set the display options for the active window, choose **Window Attributes** from the **Options** menu. A box appears in which you can change the window options.

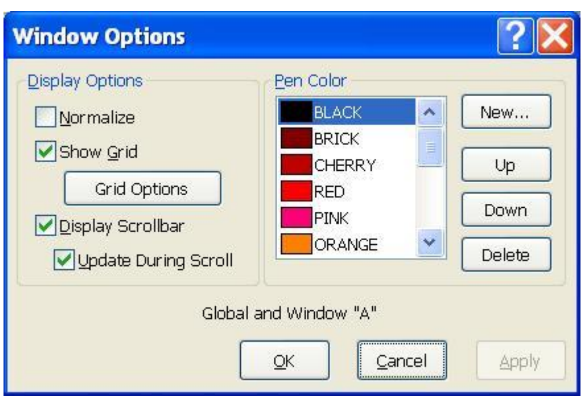

Figure 26. Window Options dialog box.

Alternatively, click the **Right** mouse button inside any open window to activate the window and display a pop-up menu. Select **Window Options** from the pop-up menu to display the Window Options box.

2. Once you change a window display setting, you can redisplay the existing data with the new window settings if you wish to change the display properties of the existing data. This can be done from within the Window Options dialog box by clicking the **Apply** button. Note that if the window contains multiple analysis data, only the topmost data will be redisplayed using the new settings. The display of earlier analysis results is not affected.
3. To close the dialog box and save the changes to the parameter settings in the initialization file, click **OK**. To close the dialog box without saving the changes, click **Cancel**.
4. If you did not apply the changes to the existing data from within the Window Options dialog box, you can redisplay the topmost data with the new window settings by selecting a display range (e.g., **All Data**) from the **View** menu.

Two color swatches appear on the left side of the status line of each window. The leftmost swatch reports the color of the current (active) plot in the window, and the rightmost swatch reports the color that will be used to draw the next plot in the window.

To quickly change the pen color:

1. To change the color of the current (active) plot, double-click on the leftmost color swatch, then select a new color from the displayed box of color swatches. The topmost graphic in the window is redrawn with the newly selected "Active" pen color.
2. To set the color for the next plot, double-click on the rightmost color swatch, then select a new color from the displayed box of color swatches. The next graphic drawn in the window will be plotted using the selected "Next" pen color.

To change the grid layout:

1. If the **Show Grid** checkbox is selected in the Windows Options dialog box, grid lines are overlaid on top of the graphics plot in the window. The placement of these grid lines can be fine-tuned.
2. In the Windows Options box, click the **Grid Options** button to display a Grid Layout box in which you can set the grid layout. Options include laying a grid on the horizontal axis and/or vertical axis, and setting the grid color. Fine-tune the grid by specifying the grid interval and the number of divisions (which are separated by ticks) per major interval, and optionally display grid labels and draw lines for the interval divisions.

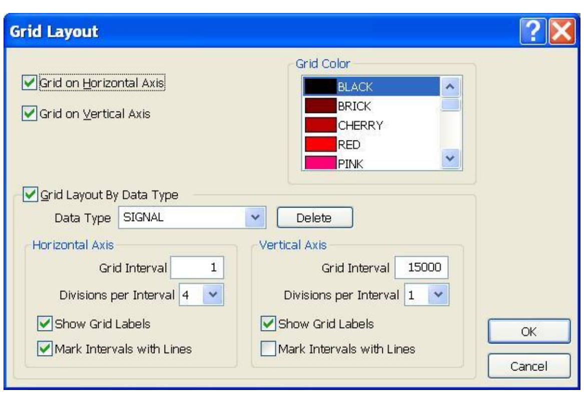

Figure 27. Grid Layout options for signal data.

3. Once changes are made to the grid layout, click **OK** to return to the Windows Options box, where you can optionally click the **Apply** button to apply the changes to the active window.

7-1-14 **Palatogram Plot**

A palatogram plot displays points of contact between the tongue and the palate as a means of showing how speech sounds are produced. Waveform and palatogram information can be stored in a single sampled data file. (This must be done externally to the program). This data file can then be loaded into the active window in the work area in order to study the palatogram results.

To display the palatogram information:

1. Ensure that palatogram information is stored with the waveform data in the active window. Select **Information on Active Window** from the **Window** menu to display a dialog box containing information about the signal. The small box beside the Palatogram description will contain a check mark if Palatometer Data are present.
2. To display the palatogram plot, select **Waveform** from the **Options** menu to display a dialog box for setting signal display options. Select the Palate attribute checkbox. A check mark will appear in the small box beside the Palate description.

   A separate palatogram window will be opened in order to display the palatogram information at the current cursor location. Drag this window to any desired location in the work area.

   The points of contact are shown as colored squares as opposed to the neutral background squares indicating no contact. (These colors are determined by your Windows setup when you first start the program: the contact color is the same as the Active Title Bar color setting, and the neutral color is the same as the Inactive Title Bar color setting.) Move the data cursor through the waveform data and observe the corresponding activity in the palatogram window.

To remove the palatogram display:

1. To hide the palatogram display box, select **Waveform** from the **Options** menu to display a dialog box for setting signal display options. Then clear the Palate attribute checkbox. The check mark will disappear from the small box beside the Palate description.
2. The palatogram plot will be hidden from view, but the information is still stored with the waveform data and can be redisplayed later.

7-1-15 **Waveform Data Display Options**

Waveform data can have IPA Transcriptions, Impulse Marks (voiced period marks), Tags, and/or Palatogram information stored with it. These signal attributes can be displayed in the window with the waveform or they can be hidden from view. In addition, waveform data that are saved in CSL signal file format can contain up to eight (8) channels of data, and waveform data in WAV format can contain up to two (2) channels of data.

To determine which signal attributes are present and the number of data channels in the waveform data in the active window:

1. Select **Information on Active Window** from the **Window** menu.

2. From the **Options** menu, select **Waveform**. You can set the following Waveform Data Display Options:
   - **Impulse Marks** - If the waveform data contains impulse marks (voiced period marks), specifies whether to display these impulse marks in the waveform data. Note that removing impulse marks from the window does not remove them from the waveform, but simply hides them.
   - **Tags** - If the waveform data contains tags, specifies whether to display these tags with the waveform data. Note that removing tags from the window does not remove them from the waveform, but simply hides them.
   - **Display Palate Window** - If the waveform data contains palatogram information, specifies whether to display a palatogram plot to accompany the waveform data. Note that removing the palatogram plot from the window does not remove the palatogram information from the waveform, but simply hides it.
   - **Upper Transcription Line** - One or two data fields can be optionally displayed for entry of IPA characters. Specifies whether to display IPA Line 1. If both transcription lines are displayed, radio buttons are activated allowing you to select which line is active (editable). Symbols in the active line will be drawn in black, while symbols in the inactive line will be in gray. Note that removing the upper transcription line from the window does not remove the IPA transcripts from the waveform, but simply hides them.
   - **Lower Transcription Line** - One or two data fields can be optionally displayed for entry of IPA characters. Specifies whether to display IPA Line 2. If both transcription lines are displayed, radio buttons are activated allowing you to select which line is active (editable). Symbols in the active line will be drawn in black, while symbols in the inactive line will be in gray. Note that removing the lower transcription line from the window does not remove the IPA transcripts from the waveform, but simply hides them.
   - **Display All Channels** - For multi-channel signal data, specifies whether to display a single channel of data or all channels of data.

7-1-16 **Put Previous Plot on Top**

A window can contain any number of compatible analysis results. If multiple analysis results are present in a window, you can scroll through the analysis data, causing the current data to move to the end of the analysis results list and the previous data to become current (topmost in the list).

Note that when you overlay multiple analysis results in a window, it can be helpful to display each calculation in a different color. For example, after generating a gray-scale spectrogram, you can overlay the formant history in red, the pitch contour in blue, and the energy contour in green.

To recall the previous analysis results in the active window:

1. Ensure that the results from more than one analysis are overlaid in the active window. The window title identifies the current (topmost) analysis data.
2. To scroll through the analysis results, choose **Put Previous Plot on Top** from the **View** menu.
3. The current analysis results are moved to the end of the results list and the previous data are brought to the top of the list. The window title changes to reflect the current analysis data.
4. You can display information about the current analysis. You can also display numerical results and result statistics for the current analysis data. Note that, because spectrogram data are transient, statistics and numerical results are not available.

7-1-17 **Help Menu**

Open Help

This manual is available in both printed form and as a .pdf file.

7-1-18 **Display Information about the Program**

You can display a box containing information about the program.

- To display this information box, select **About** from the **Help** menu.

  A box displays the version of the program along with information about the creators of the program. After reviewing the displayed information, click **OK** to remove the box from the work area.

PENTAX MEDICAL

8 Writing and Running Macros

8-1 Introduction

A macro (or command file) is a text file that contains a list of commands that are sequentially executed when the selected macro is run. Macros provide an easy way to repeat a series of commands that would otherwise have to be implemented one at a time. If any process you are performing requires repetitive steps, consider using a macro to speed up the process. Also, macros ensure that the exact same sequence of commands is used each time and are; therefore, useful for research protocols, teaching exercises for students, and clinical protocols.

You can create a command file while executing commands by setting the program to "learn" mode. All subsequent commands and command parameters that are executed (with the exception of macro commands) will be recorded to a macro file.

This application is delivered with many demonstration macros, which can have utility as written. More importantly, the demonstration macros not only illustrate the features of the program, but the usefulness of macros as well. Experiment with these macros to learn more about the program and how macros can be used.

8-2 List of Delivered Macros with Description

Macro Directory and Name	Description
..\macros\clinical	
als.mac	SPG with FMT of model versus subject target word (e.g., hail, sew, sigh, wax).
breathy.mac	LTA of model versus subject sustained "ah." Shows energy above 6 kHz in "breathy" voicing.
cepstrum.mac	Cepstral analysis of model versus subject sustained "ah."
pitch.mac	Pitch and energy analysis of stimulus file versus subject attempt.
spgnarrow.mac	Narrow-band SPG analysis of model versus subject utterance.
spgwidw.mac	Wideband SPG analysis of model versus subject utterance.
..\macros\demo	
demo.mac	Demonstration of multiple analyses in single window, and the RECALL and REMOVE features, SPG, Pitch, Energy, FFT, and LPC.
dipth1.mac	Demonstration of pitch-synchronous LPC analysis at multiple locations in captured data, placing all plots in a single window and providing instructions for using the RECALL and RESULTS functions for recalling earlier plots and examining results.

Macro Directory and Name	Description
dipth2.mac	Demonstration of pitch-synchronous FFT analysis at multiple locations in captured data, placing all plots in a single window and providing instructions for using the RECALL and RESULTS functions for recalling earlier plots and examining results.
fmt.mac	Demonstration of typical speech analysis (pitch energy, SPG [wide and narrowband], formant, FFT, and LPC analyses).
formant1.mac	Comparative analysis of vowel using Cepstrum, pitch-synchronous LPC and pitch-synchronous FFT.
formant2.mac	Analysis of sustained vowels using Cepstrum and long-term LPC.
lpc.mac	LPC of subject vowel.
mark.mac	Demonstration of selecting and marking features.
multi.mac	Demonstration of multi-pane display capability and analysis of multiple channel signals (e.g., Lx).
overlay.mac	Macro to demonstrate overlaying and recalling analysis results in a single window.
paljoe.mac	Demonstration of palate window, IPA transcription, tagged signals, and linked windows.
pch_eng.mac	Overlaid pitch and energy analysis of subject utterance.
phone.mac	Demonstration of filtering using simulated phone line filter.
pitchtst.mac	400 Hz sine wave sampled at various rates for purpose of audio card testing.
rainbow1.mac	Sequential LPC analysis of a diphthong, to illustrate placing large numbers of analysis results in a single window.
rainbow2.mac	Sequential pitch-synchronous FFT analysis of a diphthong, to illustrate placing large numbers of analysis results in a single window.
ratex.mac	Demonstration of Ratesyn function.
sampling.mac	Vocal utterance sampled at various rates to illustrate audio card capabilities and advantages of higher sampling rates.

8-3 Creating a Macro Flowchart

Creating a macro is generally a four-step operation:

1. Determine the commands necessary to implement what you want to do.
2. Create files containing the text of any messages to be displayed to the user during macro execution. It is recommended that these files be saved in HTML format, for best display results; however, text files can also be called, although the display is less attractive.
3. Configure the workspace, adjust the desired settings, and save these settings to a configuration file (i.e., an INI file).
4. Author a macro by first calling the desired INI file and then execute the desired commands. Save this macro to a file for later recall.

There are a number of detailed operations within these four general steps. These operations are described in the following flowchart:

Outline what you want the macro to do.

↓

Set the workspace (e.g., windows) and set all parameters (e.g., spectrogram bandwidth). You can wish to use a previously defined configuration file and then modify it.

↓

Use an HTML editor or text editor to create separate message files containing the text of each message to be displayed to the user during macro execution. These message files must be stored in the same folder as the macro file.

↓

Store workspace and set parameters to a configuration file: an .INI file (e.g., TEST.INI). Save this configuration by selecting Macros, Configuration, Save Current Configuration for Macro.

↓

Start recording the macro. Click **Macros** on the Main Menu and then **Record,** or use a text editor (e.g., Notepad.exe) to store a set of commands.

↓

First commands to store are commands to recall desired INI while specifying that you do not wish to save these changes by adding SET FROM before the INI file (e.g., SET FROM filename .INI) and set window work area by using the commands WINDOW RESET WORKAREA. To accomplish above, select Macros, Configuration, Reset To Saved Macro Configuration.

↓

Add operational commands to acquire, load, analyze, and speak signals. These can be recorded in Macros on the Main Menu and then Record or use a text editor.

↓

If you wish to change a set parameter from the setting in the INI during a macro, remember to reset to prior condition after using new set parameter.

↓

End macro by adding line to set to previous working environment before macro was evoked by typing two lines at end of macro SET FROM.NOSAVE INI or select Macros, Configuration, Return To User Settings at End of Macro.

↓

Use text editor (e.g., Notepad) to alter and enhance macro and INI. Save without exiting and rerun macro while editor is resident. [Alt-tab] back and forth between macro, .INI, and Multi-Speech until macro performs as desired. Always save from editor before running macro.

8-4 Creating a Macro

Creating a macro is straightforward. First, set up the settings and save the configuration. Then proceed to create your macro as follows:

1. Evoke the learn function by selecting **Macros** from the Main Menu, then **Record**. A dialog box appears.

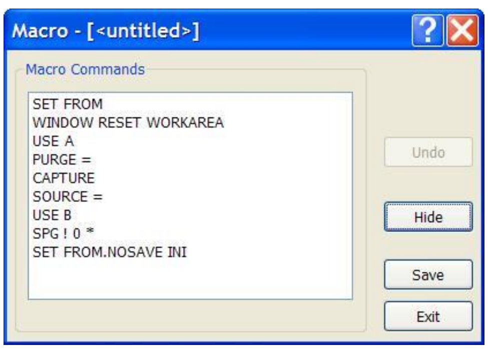

Figure 28. Macro Commands

When you create a macro, include a command at the beginning to set the parameters appropriately for the task by activating a saved configuration file (i.e., SET FROM NAME.INI). You can select this INI from the command line or from the dialog box from **Macros** on the Main Menu, **Configuration**, and then **Reset to Saved Macro Configuration...**.

2. Reconfigure the work area by using the command line (i.e., WINDOW RESET WORKAREA). This will be done automatically for you if you selected **Reset to Saved Macro Configuration...** from the menu.

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3. Add the commands you want to implement. Include a command at the end of the macro to restore the settings that existed before macro execution began by activating the previous configuration file (i.e., SET FROM.NOSAVE INI). Select **Macros** on the Main Menu, **Configuration**, and then **Return to User Settings at End of Macro**.

   Therefore, all macros will share a structure as follows with filename .INI representing the name of the INI file called for in the macro and "Insert command 1-3 here" representing the list of commands included in the macro:

   SET FROM filename.INI

   WINDOW RESET WORKAREA

   Insert command 1 here

   Insert command 2 here

   Insert command 3 here

   Etc.

   SET FROM.NOSAVE INI

4. Macro files can also be created externally to the program. Use any standard text editor to create or edit a macro file containing a series of commands, which the program will recognize and perform. If you use a word processor to write or edit a macro, remember to store it as a .TXT file (e.g., not a .doc). This file of commands is then named and saved.

8-4-1 Displaying or Hiding the Macro Dialog Box

If you entered macro "learn" mode by selecting Macros on the Main Menu, then Record, the macro dialog box is automatically displayed. If you entered macro mode from the command line, or if you have hidden the macro dialog box, you can view a macro dialog box by typing MACRO DISPLAY on the command line or by selecting Macros from the Main Menu, then Display Commands. This box displays the macro commands as they appear in the command file. Also, several buttons, which execute certain macro commands, appear inside the box. If the macro has been named, the filename appears at the top of the dialog box.

- To remove the box from the work area, click on Hide inside the macro dialog box, or type MACRO HIDE on the command line.

8-4-2 Removing a Command from the Macro

Commands can be entered by using the command line, the menu line, the toolbar, or predefined keys. Commands executed using a window dialog box are recorded, but the selection made within the dialog box is not recorded. Therefore, if you use a dialog box to make selections, you will need to text edit the macro later to add specific information.

1. If the last command was incorrectly specified, you can delete it from the command file by typing MACRO UNDO on the command line or by selecting **Macros** from the Main Menu, then **Delete Last Command**.

   Alternatively, if the macro dialog box is displayed in the work area, you can select any line in the Macro Commands box that you want to delete and click **Undo**. Then, click within the application work area and continue recording your macro.

8-4-3 Saving the Macro Without Exiting Macro Learn Mode

1. In order to save a macro without exiting learn mode, do one of the following:
   - Type MACRO SAVE on the command line.
   - From the **Macros** menu, select **Save**.
   - If the macro dialog box is displayed, click **Save**.
2. The program will display a Save Macro File dialog box. Select the directory location for the macro file and enter a filename. Then click **Save** or press Enter to save the macro.
3. The program will automatically add a .MAC extension to the file when it is saved.

8-5 Running a Macro

Once you have created and saved a command file, you can run it from within the program. Note that, as a rule, the first command in a macro is to reconfigure the work area so that windows are displayed and program parameters are set appropriately. Existing windows, and all data in them, are deleted before the new windows are displayed. **Before you run a macro, you must save to a file any existing data that you want to retrieve at a later time.**

1. To run your macro, do one of the following:
   - From the **Macros** Main Menu, select **Run.**
   - Type MACRO RUN on the command line.

   A Load Macro File dialog box appears in which you can select the macro file you wish to run. If the desired macro file is not listed, scroll through the directories until you find the file. If the file extension is not .MAC, change the extension in the **Files of Type** box.
2. Click **Open** to run the selected file, or **Cancel** to cancel the operation.

   Optionally, to run a macro you can enter MACRO RUN filename on the command line, where filename is the name of the macro file. Filename must include the file extension and can include the full directory path. This causes the named macro to be run automatically, without scrolling though the Load Macro File dialog box.

Program Configuration Files for Macros

To ensure smooth running of a macro file, it is desirable to define the work area layout and set the program parameters in a specific manner. When macro execution is completed, you want to restore the previous settings for normal program operation. You can create program configuration files, and select which configuration file to use.

1. Open and arrange windows in the work area in the layout you desire, and set the program parameters. When the program is configured to your liking, save the window layout and parameter settings to a file. Access the **Macros** menu and select **Configuration**, then select **Save Current Configuration for Macro** from the displayed submenu.
2. A standard File Saving dialog box is displayed in which you can enter a name (and optionally the drive and directory location) for the file. An INI file extension is automatically appended to the filename to identify it as a configuration file. Click the **OK** button to complete the file save operation.

When you create a macro, include a command at the beginning to reconfigure the work area and set the parameters appropriately for the task by activating a saved configuration file. Include a command at the end of the macro to restore the settings that existed before macro execution began by activating the previous configuration file.

8-6 Work Area Layout

You can save the template of a window in the active initialization file. Subsequently, you can create a new window based on the defined window template. Similarly, you can save a grouping of windows, so that you can redraw the work area to contain a defined group of windows. Commands also exist for cascading and tiling the existing windows in the work area.

8-6-1 Saving a Group of Windows

You can create a number of windows in the work area. The attributes for this group of windows can be saved to a unique group name. Later, you can reset the work area to display this defined group of windows.

1. On the command line, type WINDOW SAVEALL group_name, where group_name is a text string that will uniquely identify the group of windows. This group name will be stored in a GROUP.group_name section of the session file, along with information providing the size, position within the work area, and window settings for every window currently existing in the work area.

   This defined group will only be accessible while the current session file is valid. To save the window grouping for later sessions, the configuration must be saved to either the User Configuration or preferably another named file (e.g., SET TO NAME.INI).
2. When you save program parameters to a configuration file using the menu commands, the current work area layout is automatically saved to a group named GROUP.WORKAREA.

8-6-2 Restoring a Group of Windows

After the settings for all windows in the work area are saved to a unique group name, you can restore the work area to redisplay the saved window setup. Note that when you reset the work area with a saved group of windows, the existing windows are deleted and all existing data are lost before the new windows are opened.

To restore the work area to any previously saved setup defined in the current configuration file:

- Type WINDOW RESET group_name on the command line, where group_name is a unique name for a group of windows you have defined previously using the WINDOW SAVEALL command. If group_name is not entered, the work area is redrawn with the window setup that existed at program startup.

  When you set the program parameters from a configuration file using the menu commands, the work area is redrawn from the window group [GROUP.WORKAREA] defined in that file.

8-6-3 Rearranging the Windows in the Work Area

You can rearrange the windows in the work area so that they are cascaded or tiled. This does not affect any data in the windows. Minimized windows remain minimized.

1. To overlap (cascade) the windows with the active window in front and the title bar for each window visible, do one of the following:
   - From the **Window** Main Menu, select **Cascade**.
   - Type WINDOW CASCADE on the command line.
2. To redraw the windows with similar sizes so they are all fully displayed in the work area, do one of the following:
   - To rearrange the windows into horizontal tiles, select **Window** on the Main Menu, then **Tile Horizontally**, or type WINDOW TILE HORIZONTAL on the command line.
   - To arrange the windows into vertical tiles, select **Window** on the Main Menu, then **Tile Vertically**, or type WINDOW TILE VERTICAL on the command line.

   At any time, you can reset the work area to the window layout at program startup by typing WINDOW RESET AT START on the command line. Note that when you use this command, all data in the windows are deleted before the windows are redrawn.

8-7 Macro Example

Below is a sample print of a macro delivered with the program. Note that any line beginning with an asterisk (i.e., *), blank lines, or characters before commands are ignored by the program during execution. They are added to a macro so that the macro can be more easily understood when subsequently reviewed.

*

```
* FMT.MAC - Pitch, energy and SPG w/ FMT of sample file.
* Updated 24 March 2005
*
SET FROM.NOSAVE c:\KAYLAB\ini\demo\FMT.INI
* This set command loads the selected .INI file which stores all
* of the setup information for the commands used in this *macro.
* If user configuration changes have been made but not saved,
* the changes are automatically discarded when the new INI
* file is activated.

CLOSE ALL
* This command closes all of the opened windows so that new Windows can
* be created.

WINDOW RESET WORKAREA
* Creates the Windows, sets the source window and assigns the window to display the
* waveform data.
```

USE A

* This command makes Window A the active window and ready to receive graphic

* displays.

LOAD SPEECH.NSP

* Load the sampled data file.

SPEAK A 0 *

SPEAK A 0 *

SELECT 0.7 1.6

* Speak the file twice, then select the region from 0.7 to 1.6 seconds.

SPEAK A SS SE

SPEAK A SS SE

MOVE .95

* Speak the selected region twice, zoom in on the selected region,

* then move the cursor to a location for future analysis.

USE B

* Activate window B

PITCH A 0 *

* Do a pitch analysis of all the data.

USE C

* Activate window C

ENERGY A <>

* Do an ENERGY analysis of all the data.

USE D

* Activate window D

SPG A SS SE

* Perform a wide band spectral analysis of the selected region.

USE E

* Activate window E

SET SPG.LENGTH 512

*Adjust the spectrogram bandwidth to narrowband analysis

SPG A SS SE

* Perform a narrow band spectral analysis of the selected region.

SET SPG.LENGTH 75

*Adjust the spectrogram bandwidth to wideband analysis

USE F

* Activate window F

FFT A =

* Do an FFT analysis of the source signal at the cursor location

SET WINDOW.PEN BRICK

* Change the pen color

LPC A =

* Do an LPC analysis at the same location

SET WINDOW.PEN GREEN

* Change the pen color again

USE D

* Activate window D

FMT A SS SE

* Perform formant history calculation of selected region.

SPEAK A SS SE

SPEAK A SS SE

* Speak the selected source twice.

```
USE A
LINK B
LINK C
LINK D
LINK E
SHOW 0 *
SELECT 0 *
SPEAK A 0 *
SPEAK A 0 *
* Link all time-domain windows and show all data in A,
* select all the data, then speak all the data twice.
```

```
MESSAGE FROM FMT1.HTM
* Display a message to the user. The text of the message is stored in the file FMT1.HTM.
```

```
SET FROM.NOSAVE.INI
* This command restores the INI setting to the settings before the macro was run.
```

Appendix A. Installation of CSL Main Program and Multi-Speech

Note Specific hardware is required only with CSL. Multi-Speech is designed to work with your computer's internal graphics and a user-provided microphone. Installation of the CSL hardware is described in the *Computerized Speech Lab (CSL™) Hardware and Installation Manual*.

A-1 CSL Components

See Section 2-1, *System Components* and the *Computerized Speech Lab (CSL™) Hardware and Installation Manual* for details.

A-2 Multi-Speech Components

Unpack and inspect Multi-Speech. The following parts should be included:

- Instruction manual.
- Software (Multi-Speech application CD. If you purchased options, they appear on separate CDs.
- Software security key.

Note If for any reason parts are damaged or missing, immediately contact the factory or PENTAX Medical representative

A-3 Major Steps for Installation of CSL and Multi-Speech

There are two major operational steps for CSL; if you are installing Multi-Speech, skip to step 2.

1. Install CSL 4500b hardware:

   See the *Computerized Speech Lab (CSL™) Hardware and Installation Manual* for details.

   a. Install the PCIe sound card into the computer.

   b. Connect the CSL to AC power source, microphone, speaker, and computer (using cable).

2. Install application software, device driver (CSL 4500b only), and security key driver for the CSL 4500b or Multi-Speech.

A-3-1 Installing CSL Hardware

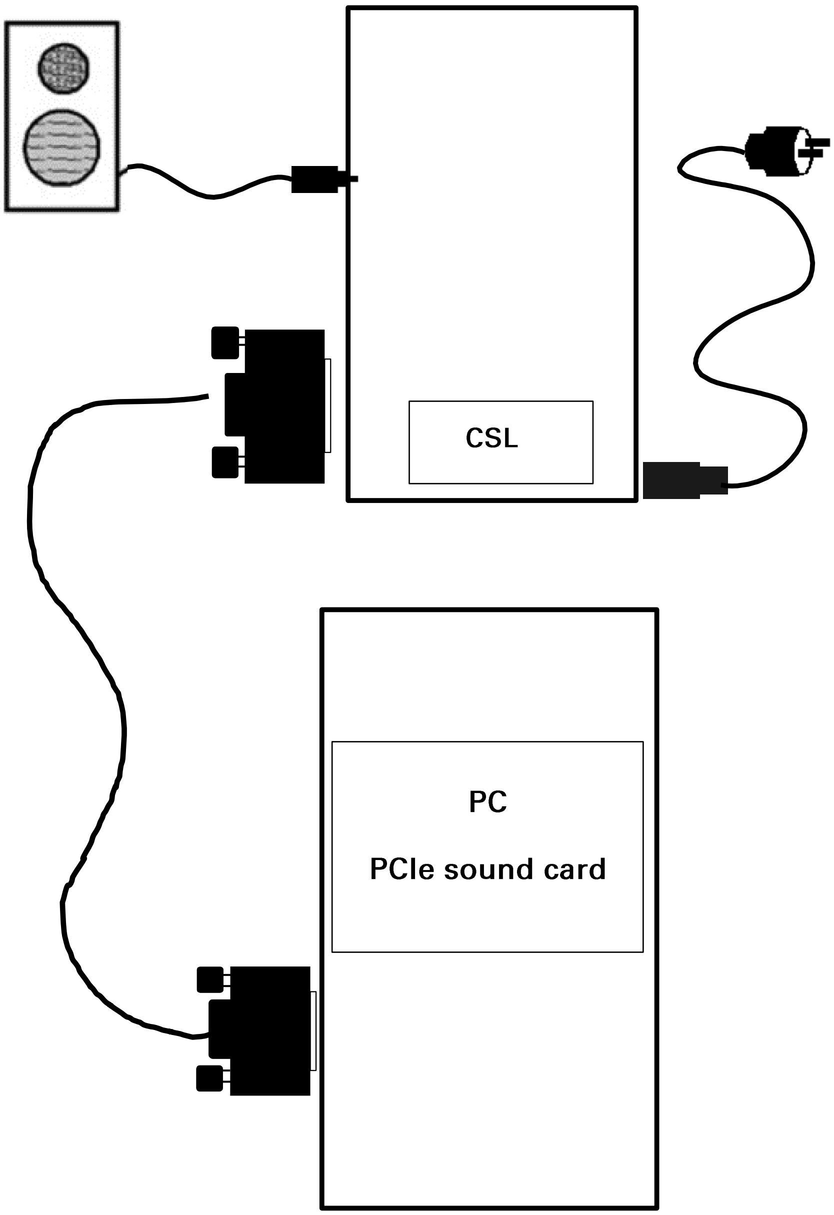


Figure 29. CSL Hardware Schematic

Appendix B. Software Installation

Before you install CSL software, make sure that you install all hardware components. Refer to Appendix A, *Installation of CSL Main Program and Multi-Speech*, and to the *Computerized Speech Lab (CSL™) Hardware and Installation Manual* for details.

B-1 Installing CSL Main Program and Multi-Speech

Note These instructions use CSL windows to illustrate the installation process. Multi-Speech windows follow the same sequence.

B-1-1 Installing Application Software

To install the CSL 4500b or Multi-Speech software:

1. Insert the *Software Installation Disc and Software Instruction Manual* CD.

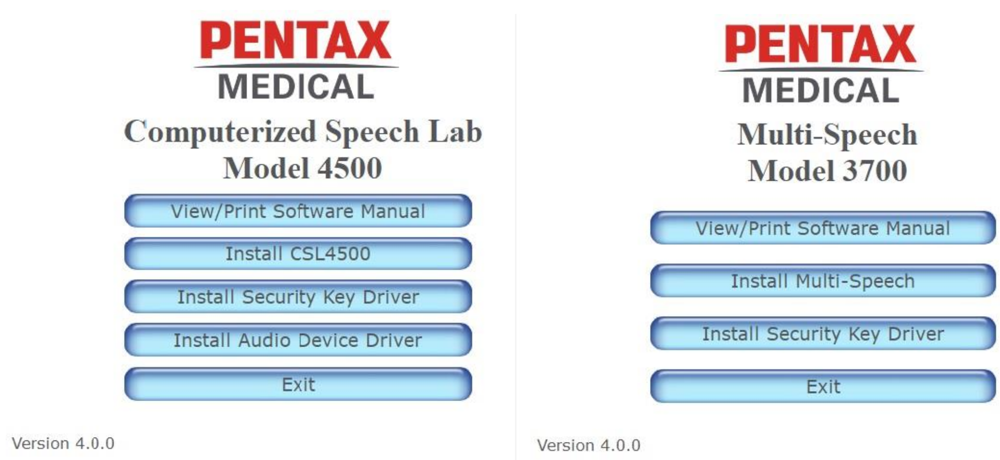


Figure 30. CSL 4500b and ms installation menu

2. At the installation menu, click **Install CSL4500** or **Install Multi-Speech**.

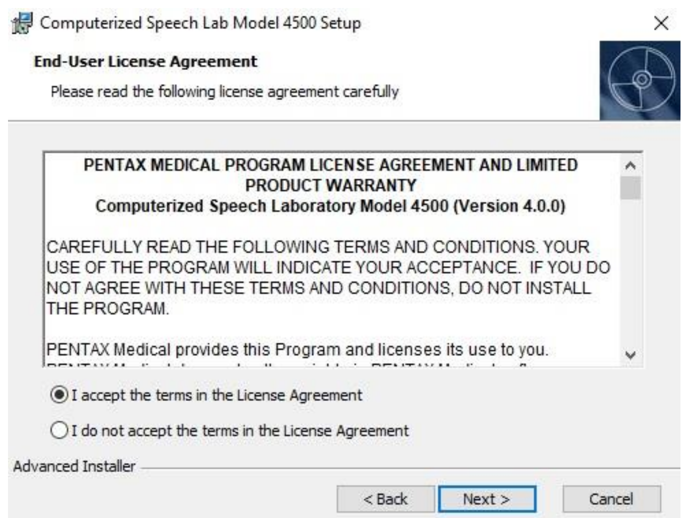
   If this menu appears, skip to step 3; if it does not appear, go to step 3.

3. If the installation menu does not appear, launch the application manually:
   a. Open File Explorer and navigate to your CD drive.
   b. Double-click **autorun.exe**.

4. Use the Setup Wizard to install the application.

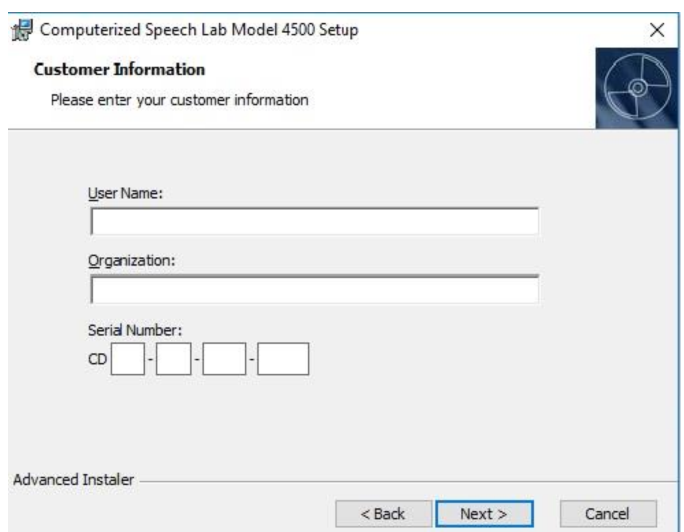
   a. At the Setup Wizard window, select **Next**.

   b. At the End-User License Agreement, click the button to accept terms and then click **Next**.



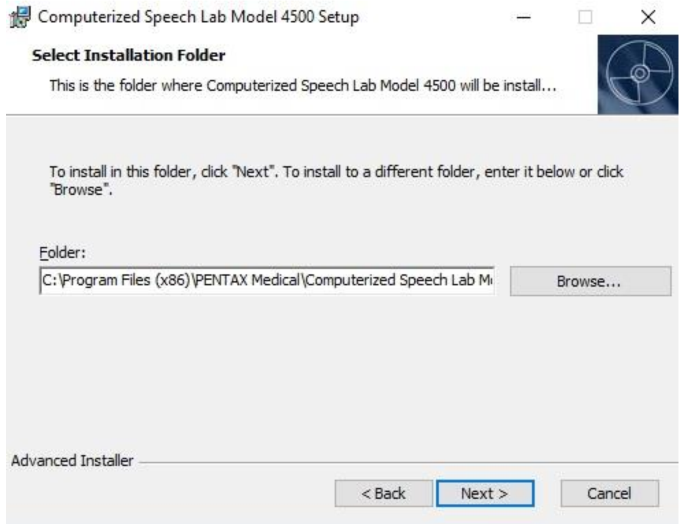
   c. At the Customer Information window, enter your user name, organization, CD Serial Number, and click **Next**.

      The serial number appears on the CD packaging

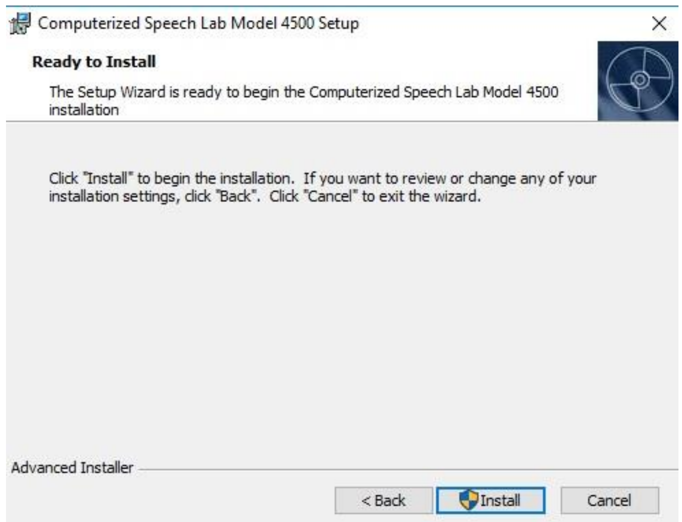


d. At the Select Installation Folder window, click **Next** to install software at the default location.

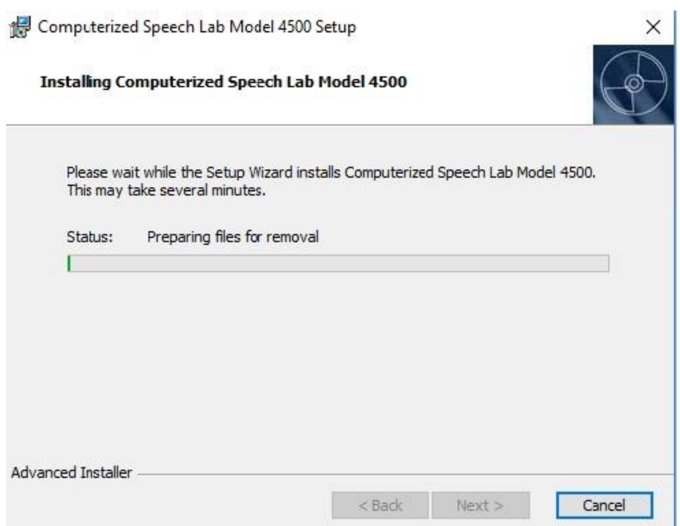
You can also navigate to another folder.



e. At the Ready to Install window, click **Install**.



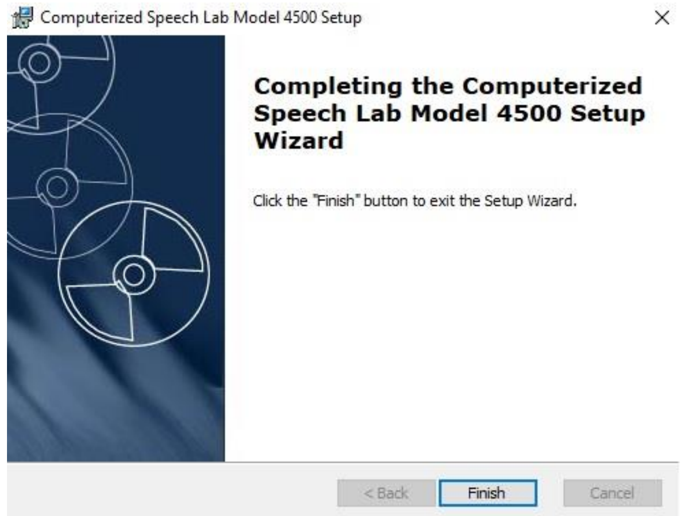
A status bar tracks the installation process.



f. When the process is complete, click **Finish**.

The Installation menu appears again. For CSL, can now install the audio device driver.

For Multi-Speech, skip to Section B-1-3, *Installing the Security Key Driver*.



B-1-2 Installing the Audio Device Driver

After you install the application software, you can install the audio device driver for CSL:

1. At the Installation menu, click **Install Audio Device Driver**.

Note Do not plug the security key into the computer's USB slot until you install the driver.

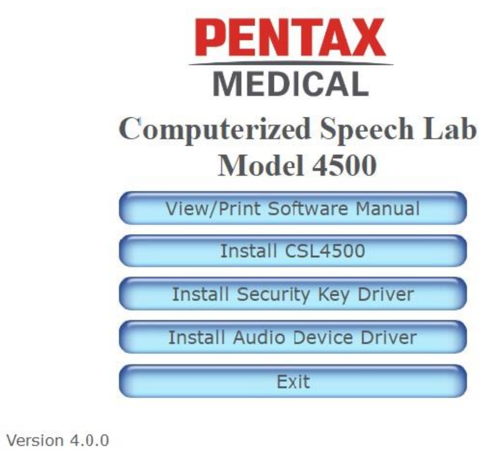
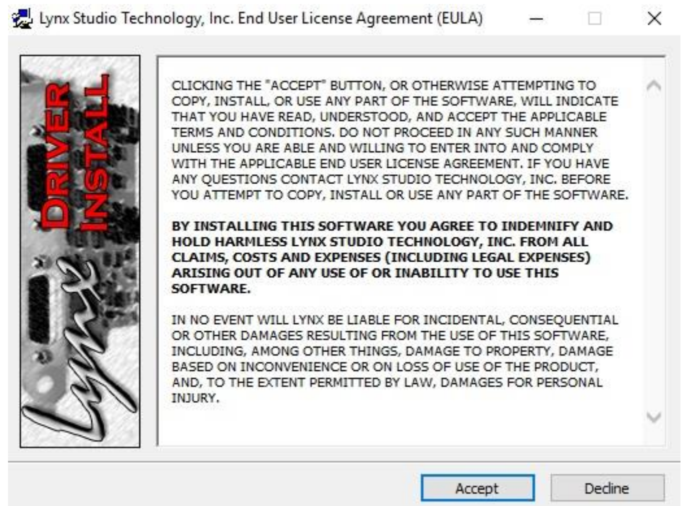
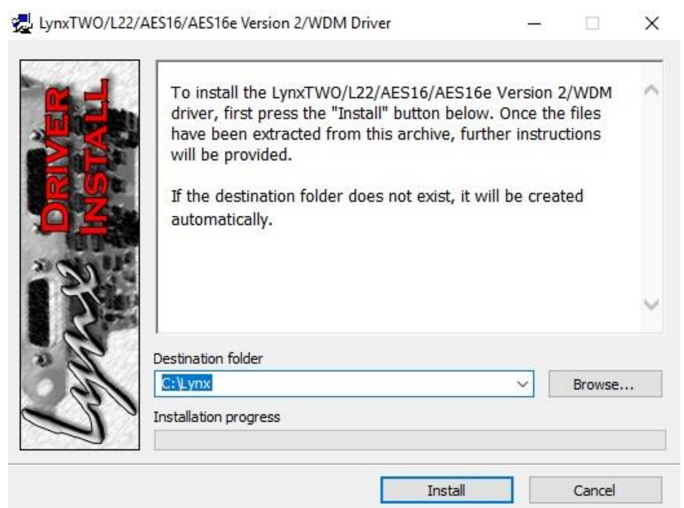


Figure 31. CSL 4500b installation menu

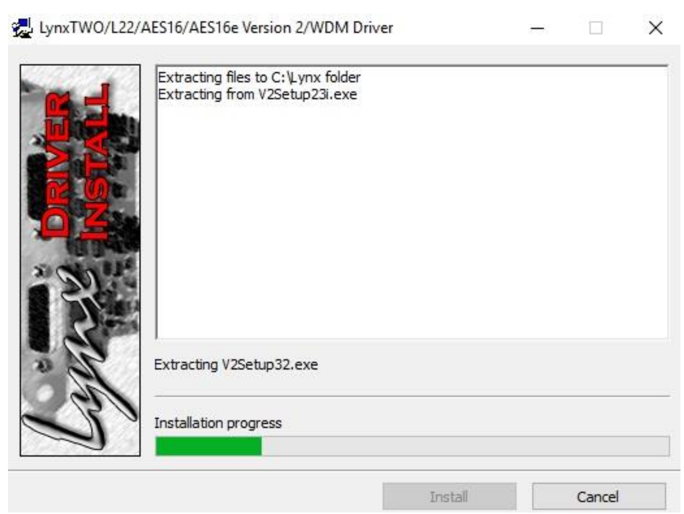
2. At the End User License Agreement window, click **Accept**.



3. At the next window, the default destination folder appears:
   - Click **Install** to accept the folder.
   - Click **Browse** to select another destination.



A status bar tracks the installation process.



4. At the Welcome window, click **Install**.

5. When the process is complete, click **Restart**.

   The Installation menu appears again. You can now install the security key driver.

B-1-3 Installing the Security Key Driver

After you install the application software, the audio device driver for CSL, and restart your computer, you can install the security key driver.

1. Open File Explorer, navigate to your CD drive, and double-click **autorun.exe**.
2. At the Installation menu, click **Install Security Key Driver**.

Note Do not plug the security key into the computer's USB slot until you install the driver.

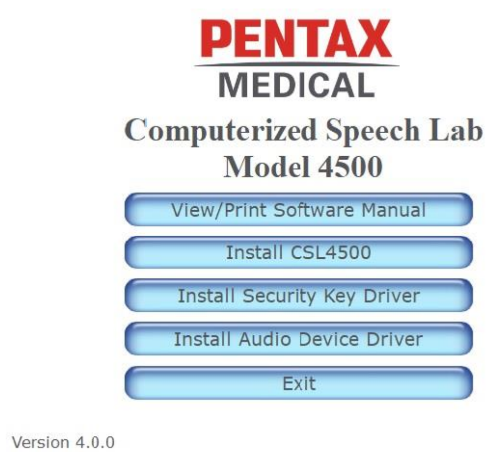
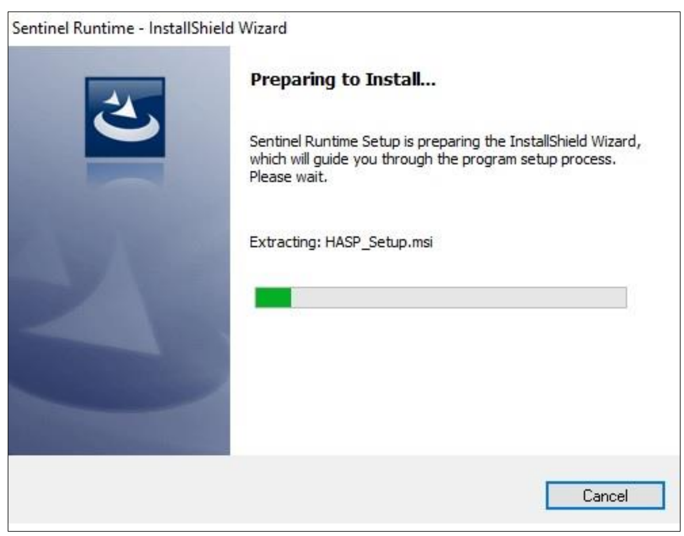
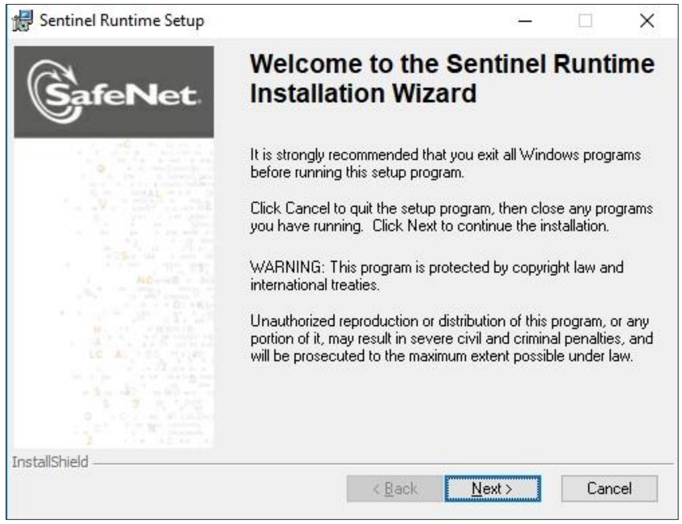


Figure 32. CSL 4500b installation menu

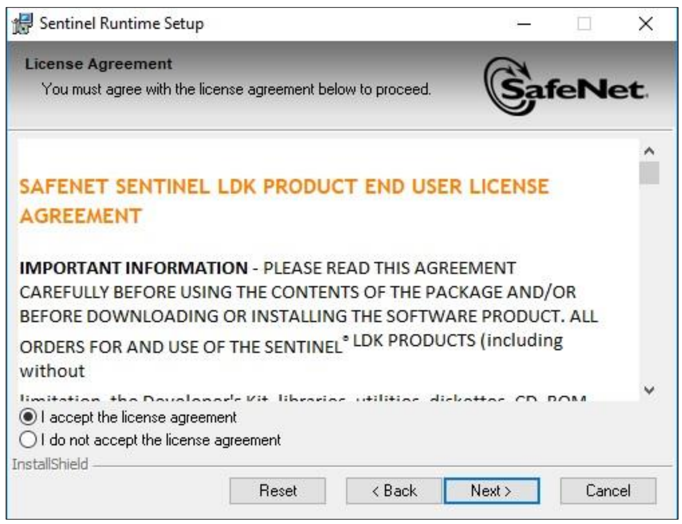
3. The Preparing to Install window appears.



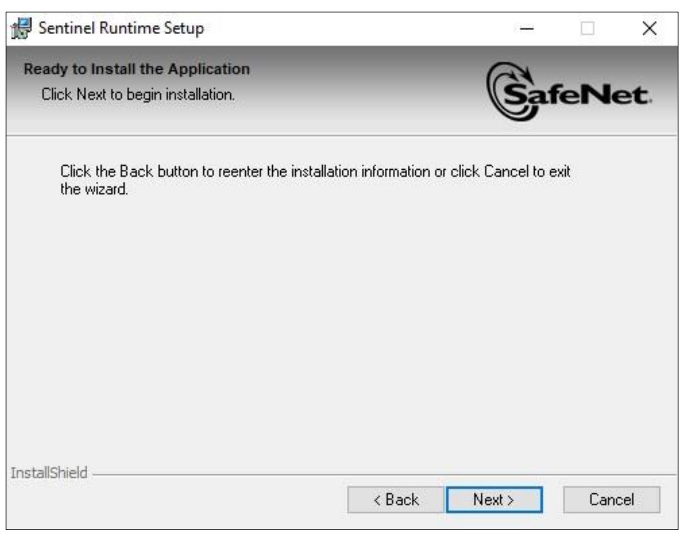
4. At the Sentinel Runtime Installation Wizard window, click **Next**.



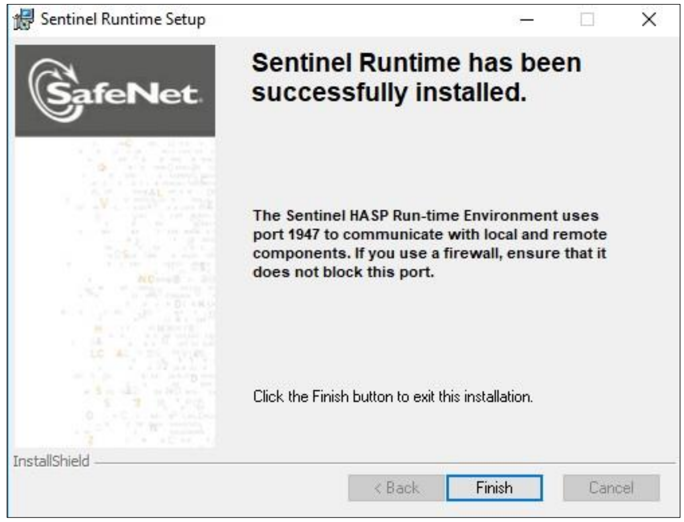
5. At the License Agreement window, click the button to accept terms and then click **Next**.



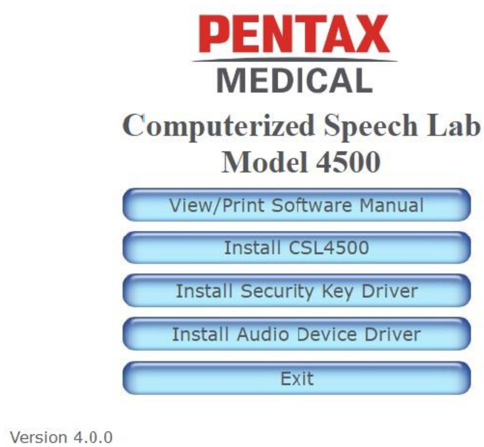
6. At the Ready to Install window, click **Next**.



7. When the process is complete, click **Finish**.



8. At the CSL4500b installation menu, click **Exit**.



9. Remove disc from CD drive and reboot the PC to complete security key installation.
10. Plug the security key into an available USB port on the host computer.

    Refer to Section 3, *Installation and Loading*, for additional information.

B-2 Operational Qualification of Equipment

After you install software, ensure that the system is operating successfully:

1. Install the PCIe sound card.
2. Install the Acoustic 4.0 Software on the PC as specified in *Speech Products Software Installation Instructions*.
3. Connect the DB25 cable between the PCIe sound card and the 4500b.
4. Ensure that the PC power is supplied through a 9175 Isolation Transformer, if provided.
5. Apply power to the 4500b.
6. Open the CSL 4500b main program.
7. Connect a microphone to an input channel.
8. Capture data on the channel you selected.
9. Play the sample.

   If the data capture and playback are successful, the operational qualification is complete.

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Appendix C. Audio Cards

C-1 Introduction

Multi-Speech is a software product dependent on a host computer and audio card (purchased separately) for many operations (i.e., input and output). Most of PENTAX Medical's other products are delivered with the necessary peripheral hardware (e.g., CSL, Visi-Pitch, and Nasometer, etc.). Therefore, the quality of the operation of the Multi-Speech is dependent on a third-party audio card, which is out of PENTAX Medical's control. To compound this problem, most of the audio cards available have significant operational and performance shortcomings when compared to professional-level hardware such as digital recorders Visi-Pitch, and CSL. These similarities and differences are also discussed in Introduction.

Often the specifications for these cards are not described in the manufacturer's documentation typically provided, or the specifications are idealized and rarely met when installed in typical computer environments. There are many audio card manufacturers and quick turnover of models. Our challenge, given the above difficulties, is to provide some guidance about using, evaluating, and selecting these cards. As stated previously, PENTAX Medical recommends that, whenever possible, a professional-level input system (e.g., digital recorder CSL, or Visi-Pitch) be used for input to ensure good quality recordings.

C-2 Table of Audio Card Cautions

Feature	Caution
Hardware Delivered	Your sound system may or may not include a microphone, speaker(s), or headphones. Check delivered components and the quality of the components.
Overall Input Quality	Generic audio cards have input SNR of about 40-60dB depending on the audio card design, the location of the card in the computer, the noise level of the computer, the microphone, and other considerations. As a frame of reference, note that CSL, Model 4500b, and Visi-Pitch, Model 3950c, use professional-level components and an external module to achieve input signal-to-noise ratios (SNR) above 91dB. The difficulty in selecting a generic audio card is that few manufacturers specify the input SNR, and when specified it is idealized. In reality, the specifications vary depending on the installation in each computer. Even top grade generic audio cards (e.g., Creative Lab's top-of-the-line consumer card) are considered better quality input systems but still have significantly more noise than professional components designed for measurement (e.g., PENTAX Medical products) or studio music applications.
Microphone	Most audio cards include inexpensive, limited-frequency-response dynamic microphones. Multi-Speech users should consider upgrading to a better microphone if acquiring signals using the audio card. Note that a professional condenser-type microphone is specified by the National Center for Voice and Speech Recommendations for Voice Analysis. Microphones also vary in their output levels and not all microphones are matched to the preamplifiers included with the board. You can need to experiment with various microphones or external preamplifiers to find a suitable combination for your sound board.

Preamplifier	Few audio card manufacturers specify gain and SNR of their preamplifier. You can wish to consider purchasing a separate external preamplifier, which is then connected to the line-level input of the audio card, to improve the noise performance. The preamplifier on your card can have insufficient gain or, if available, the high-gain setting can introduce too much noise. Symptomatic of a low-gain preamplifier is a subject having to speak loudly into the microphone to reach full amplitude levels even when the gain for the audio card's input sensitivity is on its highest setting. Also, note that the audio card exhibits the highest DC offset and noise when the input levels are set to their highest setting.
Input Anti-aliasing Filters	To accurately acquire signals (i.e., converting from an analog signal to a digital representation), without aliasing higher frequency components to the frequency range of interest, an anti-aliasing filter is required. These filters should adjust to the sampling rates and have greater than 100dB/octave roll-off. With generic, low-cost audio cards, the user should be aware of the characteristics of the anti-aliasing filters, at which sampling rates they are used, and the capability (or lack thereof) to automatically track the set sampling rate. This can be especially problematic when high-frequency signals are present above the sampling rate of interest. For example, computer monitors often generate high-frequency signals (about 15000 Hz) at the flyback frequency that could inadvertently alias an improperly filtered signal sampled at 44100 Hz. Tape recorders can also have signals above the listener's hearing range that will "mix" with the signal of interest during A/D conversion if not filtered. Again, because audio card manufacturers do not provide these specifications, users should test their input system before applying to serious work. If CSL or Visi-Pitch is used for input, you will not need to test because Visi-Pitch and CSL have input anti-aliasing filtering to fit the requirement noted above. CSL and Visi-Pitch filters automatically adjust to the set sampling rate.
Noise	Noise is any unwanted signal mixed with the signal of interest. The section following this table provides some guidance on noise measurement in your system. Generic audio cards use a 16-bit A/D converter but often the bottom 7 to 8 bits of the input range are corrupted by noise. Therefore, the theoretical resolution of the system of 96dB is limited to about 40-60dB. Pick the best card, and evaluate it carefully before using. If your applications (e.g., clinical measurements or research) demand better input specifications, use a professional-level system for input. These systems include CSL and Visi-Pitch available from PENTAX Medical and other companies (e.g., Turtle Beach). Noise can also be aggravated by turning the AGC on. During capture, turn AGC OFF when possible.
DC Drift	An alternating signal such as received from a vibrating microphone diaphragm should produce voltages that vary around zero. The resultant digitization will produce a signal with values varying around 0. If you plotted the waveform, the center line should be 0. Electronic circuits can, unfortunately, drift so that the signals do not vary around zero. This DC drift varies with temperature. A listener cannot hear this DC drift. Measurements, however, can be affected by this drift. Professional-level components are attentive to DC drifts and will autocalibrate to eliminate drift. You can wish to use the test in this appendix (next section) to measure the DC drift of your system at various levels of system warm-up.

Output Sampling Rate	CSL and Visi-Pitch support a wide range of I/O rates. Many audio cards do not. If you play back a signal, which was acquired on CSL or Visi-Pitch, on a multimedia audio card, that card cannot support the acquisition rate and the output will be distorted. This is especially true with the rates higher than 44100 Hz and lower than 11025 Hz rates. Multi-Speech users should not infer from this distorted output that the stored signal is distorted. The Multi-Speech macros for playing out signals at different sampling rates (i.e., SAMPLING.MAC) can be used to evaluate the flexibility of the audio card. We have found that the higher-end Creative Labs cards do the best job of supporting various output rates between 11025 Hz and 44100 Hz. No card will support all of the sampling rates used by CSL and Visi-Pitch.
Output Anti-aliasing Filters	To eliminate sampling "noise", a digital-to-analog conversion of signals should use an adjustable filter appropriate to the I/O sampling rate. In generic audio cards, these specifications for output filtering cannot be delineated in the audio card's documentation. You can be able to achieve the desired output sampling, but not necessarily the correct output anti-aliasing. Users of generic audio cards should not assume that a noisy or distorted output means that the stored signal is corrupted. It could simply be an output problem.
Adjusting Input Sensitivity	With generic audio cards, you will need to repeatedly acquire, check levels of signals, stop acquiring, evoke audio card controller program, adjust, go back to Multi-Speech, and reacquire in order to set the input level correctly. The awkwardness of this operation typically yields signals with more overloads or an underutilization of the dynamic range (i.e., underloading). CSL and Visi-Pitch allow the input sensitivity to be adjusted during input so that overloading is avoided and the dynamic range of the input is used effectively.
Linearity	In a trade-off suitable for most applications, but unsuitable for measurement applications, many audio cards allow the input amplifier to be overloaded without warning flags before the A/D is overloaded. This is done to avoid the more aurally unpleasing overloading of the A/D. However, users can be overloading and distorting measurements of the system on the input amplifier without warning because the A/D is still not fully utilized. As a result, the amplitude and spectral accuracy of the signal is compromised. CSL and Visi-Pitch preserve linearity and accuracy and match the input amplifier, A/D and warning flags to avoid overloads.
Adjusting Output Volume	The software setting for most audio cards requires you to stop playing to make adjustments. If you are using an external speaker, you should be able to adjust the output volume of the speaker without interrupting output. Multi-Speech users, who use headphones, can wish to explore getting headphones with volume adjustments.

Flagging of Overloaded Input	Overloads (i.e., clipping) in digital systems can be disastrous for data analysis. Generic audio card software does not have the ability to identify overloaded sample points during acquisition or even after the signal is acquired. The audio card hardware does not have the ability to detect overloads at the A/D converter. Multi-Speech software does flag suspected overload points after the signal is acquired by showing a color change in the waveform display. It does this by analyzing the signal characteristics. If you use these generic audio cards for input, users should be careful to avoid overloading. Before analysis, you can note the waveform display to see if the trace changes color. When overloads are detected, color changes and a flat top appearance of the waveform occur at overloaded sections of the waveform. Before analysis, you can want to look closely at the waveform for overloaded segments.
Calibrated Input	Generic audio cards do not have a calibrated input. Users cannot know the absolute level of a signal. Therefore, all measurements are relative to other portions of the signal. Even relative measurements are not possible if the AGC is ON. AGC should always be set to OFF for any measurement task.
DC Coupling	AC coupling is used for microphone signals, but DC coupling is used for electroglottography, air flow, and other low-frequency content signals. Generic audio cards do not typically include DC coupling and cannot, therefore, be used to analyze low-frequency information reliably. If you need to analyze these types of signals, use CSL, because this system includes the ability to set the input to either DC or AC coupling.
Support	Consult your audio card manual for support information. PENTAX Medical will support Multi-Speech software, but PENTAX Medical cannot support the service or operation of the third-party audio card.

C-3 How to Check the Input Signal-to-Noise Ratio of a Generic Audio Card System

As stated previously, few sound board manufacturers specify their input SNR. For those that do specify it, our studies have shown that these specifications are idealized and are rarely met in the typical user's computer system. The specifications depend on the installation and the computer. Therefore, it is useful to determine the SNR of the audio card in your system. CSL and Multi-Speech include analytical tools that can be helpful in assessing the quality of your system's input circuits. For example, by initiating capturing with no signal attached, the resultant captured signal can represent some of the background "noise" of the system. An understanding of how unwanted noise can be mixed with the signal of interest will improve your ability to interpret the analysis of a signal compromised by noise. Noise is generally taken to mean random fluctuations, added to or modulated with, a wanted signal. Here, however, noise means any unwanted signal, periodic or not, existing with a desired signal.

When you use a multimedia card, you can unwittingly report analysis results (e.g., energy levels, jitter, harmonic/noise ratios), which have been significantly altered by noise, added during signal acquisition. You can be adding noise without realizing it. This problem is the reason why the National Center for Voice and Speech recommends that the system you use to make voicing measurements should have an input SNR of over 86dB and that it should include robust anti-aliasing filters to filter out unwanted frequency components.

Any method of acquiring and storing signals can affect the signal quality. Noise can be introduced during signal acquisition in a number of ways. System components (e.g., microphone, cabling, preamplifier, amplifier, anti-aliasing filters, and A/D) could be of poor quality. The CSL and Visi-Pitch models use professional-level system components and careful design that minimize system-generated noise. However, if you acquire with other products, you should evaluate their performance. Additionally, noise sources (e.g., fan noise, electromagnetic signals from monitors or fluorescent light fixtures, power supply hum) can inadvertently be acquired along with the signal when using the best equipment. Poor room acoustics can also add noise.

When analog signals are converted to digital signals (and vice versa) on an audio card inside a computer, the input and output circuitry can be affected by computer noise. To avoid this, most products for professional sound applications (PENTAX Medical's CSL, Visi-Pitch, digital recorders, etc.) use an external module, isolated from the noisy computer, to perform the analog-to-digital and digital-to-analog conversion. Inherent in plug-in cards is their susceptibility to computer-generated noise. It is not a design flaw of the audio card.

A digital storage system (e.g., computer acquisition, digital recorder) converts the incoming continuous analog signal to a discrete digital signal. Converting an analog signal to a digital representation is performed by an analog-to-digital converter (A/D converter). Most systems today use a 16-bit A/D converter that produces a 16-bit binary number to represent the range of incoming values. A binary number with 16 places has a range of 2^{16} or 65536 possible values. This range of values equals 96dB of possible signal level variation (20 log 65536). This is the maximum achievable range, also called the dynamic range, with a 16-bit linear converter. The full 96dB range, however, is seldom achieved because the associated electronics can rarely take advantage of the full dynamic range available. For example, most audio cards, which plug into a computer, can lose half of the dynamic range to system noise and large DC offsets. DC offset is characterized by signals not varying around 0. An AC-coupled microphone signal needs to be centered about 0 for full peak-to-peak performance.

One simple way to perform a partial check of a recording system, without the need for test equipment, is to acquire a signal exactly as you would during your work, except with the microphone turned OFF. (Admittedly, this is only a partial check of the system because unbalance microphones can pick up noise, which cannot be detected in this test.) Then, using Multi-Speech, analyze the acquired signal for noise by pressing [F9] and checking the Level value in the Signal Information dialog box or by scrolling the cursor along the waveform to note the cursor values. The waveform display cursor reads the waveform values as a linear value (with values ranging from 0 to ± 32768). Use the table that follows to correlate the linear waveform value of the cursor with the noise level and SNR ratio. If you repeat the above test with the microphone on (but quiet), you can separately measure the noise added by microphone pickup of acoustic and electromagnetic signals. For example, if the values range -200 or +200, under either condition, the eight or nine least significant bits (about 50dB) are corrupted by noise. The true dynamic range of the 16-bit A/D has been reduced from 96dB to about 46dB. As another example, if no microphone is attached and the values are 150 ± 32 (i.e., values range from 118 to 182), there would be almost 45dB of DC offset and 36dB of random noise. Please note that this is not a foolproof test because the noise in the computer can be intermittent. For example, the hard drive (which could turn on if virtual memory is used) could produce a noise spike only occasionally and cannot be detected in the above test.

For voice measurements, a useful dynamic range of above 85dB is recommended by the National Center for Speech and Voice. This means that the noise should fall within the range of -2 to +2 using the tests described above.

C-3-1 Cross Reference: Waveform Value-to-Noise Level and SNR

Linear Waveform Values for Noise	Affected Bit	Noise Level	SNR Ratio
± 1	16th (least significant)	6dB	90dB
± 2	15th	12dB	84dB
± 4	14th	18dB	78dB
± 8	13th	24dB	72dB
± 16	12th	30dB	66dB
± 32	11th	36dB	60dB
± 64	10th	42dB	54dB
± 128	9th	48dB	48dB
± 256	8th	54dB	42dB
± 512	7th	60dB	36dB
± 1024	6th	66dB	30dB
± 2048	5th	72dB	24dB
± 4096	4th	78dB	18dB
± 8192	3rd	84dB	12dB
± 16384	2nd	90dB	6dB
± 32768	1st (most significant)	96dB	none

C-4 Conclusion

PENTAX Medical recommends that a professional system (e.g., CSL, Visi-Pitch) be used whenever possible for reliable, high-quality input. In all cases, it would be useful to use the measurement techniques recommended above to evaluate your system's performance before use. If a professional system is not available, use a USB-based microphone (e.g., Telex), a USB-based external box (Roland), or an audio card from a company with a reputation for good quality input and with known specifications for acoustic input. These include the best cards from Creative Labs with balanced input.

You can wish to consider connecting an external preamplifier (with XLR input), a better quality microphone (XLR type), and an upgraded sound system to improve your system's performance. The use of an external preamplifier helps protect the low-level microphone signal from corruption from computer noise. The external preamplifier boosts the signal level to higher levels that are, therefore, less susceptible to noise. Note that this is a help, not a cure.

Even if you can find an audio card and an operating environment with acceptable sound quality, you will need to be cautious about overloading, because there will be no direct feedback of overload conditions, particularly if the overloading is at the pre-amplifier.

Not all sampling rates are supported by audio cards. When possible, use standard multi-media rates (11025, 22050, and 44100 Hz) for acquisition. These sampling rates are supported by most audio cards. The Sound Blaster cards seem to do the best job of supporting the most sampling rates.

All audio cards are likely to have significant operating and performance weaknesses when compared to professional-level hardware systems (e.g., CSL and Visi-Pitch). These performance tradeoffs are inherent in their low-cost design and cannot be completely avoided. Users must, in all cases, proceed cautiously in order to ensure good quality signal acquisition and output.

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Appendix D. Specifications

D-1 CSL Model 4500b Specifications

Class: Class I Equipment

Type B Applied Parts

	Input Channels 1 & 2	Input Channels 3 & 4
Type	Microphone and line	Line
Connection	XLR and 1/4" combo	RCA
Coupling	AC coupled	AC coupled or DC coupled (hard switch selectable)
Gain Range	> 38 dB	> 36 dB
Input Signal Range (Full Scale)	XLR: -52.8 dBu to -15.6 dBu (5 mVpp to 360 mVpp) 1/4": -24.5 dBu to 12.3 dBu (130 mVpp to 9.0 Vpp)	24.5 dBu to 12.3 dBu (130 mVpp to 9.0 Vpp)
Frequency Response	(-3 dB): 20 Hz to 88 kHz	AC Mode (-3 dB): 18 Hz to 88 kHz DC Mode: Low-pass roll off at 88 kHz
DC Offset	< 0.3% Digital F.S.	< 5% Digital F.S.
THD+N	< -90 dB @ -3 dB FS (F.S. = 12.3 dBu)	THD+N: < -90 dB @ -3 dB F.S. (F.S. = 12.3 dBu)

	Output Channels 1 (Left) & 2 (Right)	Auxiliary Output Channels 3 & 4	Headphone Outputs*
Type	Speaker and line	Line	1/4" Phono jack
Connection	RCA	RCA	—
Coupling	AC coupled	AC coupled	
Gain Range	> 38 dB (speaker outputs only)	—	>38 dB
Output Power	3 watts per channel (speaker outputs only)	—	—
Frequency Response	4 Hz to 88 kHz (3 dB)	—	—
THD+N	< -90 dB @ -3 dB Digital F.S. (measured on line output)	—	—
Balance	Not implemented in hardware	—	—

*Outputs are disabled when the headphones are in use. Warm-up time: 20 minutes

Power Supply	• Front panel on/off switch • Type: Universal AC input • Model: SRW-100-3002 • Manufacturer: Integrated Power Designs • Input: 85 – 264 VAC, 47 Hz – 63 Hz • Outputs: +5V DC/10A, +15VDC/3A, -15VDC/1A • Weight: 1.0 lbs. • Expected Usage: 45 VA watts (max.)
Input Power	100 – 240 VAC, 50 – 60 Hz, 60 VA
Fuses	T2.0A/250V, 5mm x 20mm, Schurter 0034.3120 or equivalent
Specialty Functions	VRP Mode: • Variable gain of channels 1 & 2 disabled • Channel 1 variable gain stage set to 30 dB ±0.5 dB • Channel 2 variable gain stage set to 3 dB ±0.5 dB • Channel 1 signal routed to channel 2 gain stage
Enclosure Type	Custom enclosure to include PENTAX Medical front and rear bezels. Dimensions: • Length: 12.5" • Width: 4" • Height: 8.25" • Weight: 4.75 lbs.
Environmental	Operating: • Temperature: +10 °C to +40 °C • Relative Humidity: 30% to 90% (non-condensing) • Atmospheric Pressure: 700 mb to 1060 mb Storage/Transportation: • Temperature: +10 °C to +40 °C • Relative Humidity: 30% to 90% (non-condensing) • Atmospheric Pressure: 700 mb to 1060 mb

D-2 Model 4500b Audio Card

Type	PCI EXPRESS (Lynx E44 Modified)
Analog I/O	• Type: Four inputs/four outputs, electronically balanced or unbalanced • Level: +20dBu full scale or variable +8.23dBu to +24dBu full scale jumper selectable - software selectable in channel pairs • A/D and D/A Type: 24-bit, multi-level, delta-sigma • Sample Rates: 11.025 kHz, 22.05 kHz, 44.1 kHz, 88.2 kHz, 96.0 kHz, 176.4 kHz, 192.0 kHz
Analog Input Performance: (measured in 24-bit mode with card installed in computer)	• Frequency Response: 20 Hz – 20 kHz, ± 0.05 dB at 44.1 kHz sample rate • Dynamic Range: 117 dB, A-wtd. • Channel Crosstalk: <-120 dB, 1 kHz signal @ -1dBFS • THD+N -111 dB (0.0003%) @ -1 dBFS, 1kHz signal 22Hz-22kHz BW
Analog Output Performance: (measured in 24-bit mode with card installed in computer)	• Frequency Response: 20 Hz– 20 kHz, ± 0.05 dB at 44.1 kHz sample rate • Dynamic Range: 117 dB, A-wtd. • Channel Crosstalk: <-120 dB, 1 kHz signal @ -1dBFS • THD+N -108 dB (0.0004%) @ -1 dBFS, 1kHz signal 22Hz-22kHz BW
Connections	• Audio Port: Bracket-mounted 25-pin, female, D-sub connector for analog audio input and output • Sync Port: Bracket-mounted, 15-pin, high-density, female, D-sub connector for digital input and output
Software	• Windows Drivers: Windows 10: MME, ASIO 2.0, and DirectSound
General	• PCI EXPRESS Bus: x1 – x16 • Size: 5.0” H X 7.4” W X 0.75” D (half-size PCI EXPRESS card) • Shipping Weight: 3.25 lbs. with cables • Certifications: CE and FCC Class B
Cables	• Analog I/O: 25-pin, D-sub male to female • Female XLR to RCA on shielded twisted pair cabling • Male XLR to RCA on shielded twisted pair cabling

Appendix E. Troubleshooting

This section provides some tips and strategies for some of the problems you might encounter while operating the program. Note that troubleshooting steps can be different when using CSL hardware, Multi-Speech with a pre-amplifier, or Multi-Speech without a pre-amplifier.

Problem	Possible Solutions
When installing CSL or Visi-Pitch, the host computer does not have a free PCI slot	You must remove one of the devices currently using a PCI slot (an audio card, or a different computer.
When launching the software, receive the message Security key not found" or "Command unknown"	The security key is not inserted and/or the security key driver has not been properly installed. Plug security key into an available USB port and ensure that a red light appears on the USB key to show it is activated. If key is already inserted or message still occurs, reload the security key driver.
When using CSL 4500b or Visi-Pitch, "New Hardware Found" dialog box continues to display when the system is turned on	The PCIe sound card driver cannot be installed properly.
No data is captured when using CSL 4500b or Visi-Pitch, after selecting Record	Check that the CSL or Visi-Pitch Hardware is powered on and properly connected, and that the microphone is powered on and properly connected. See the *Computerized Speech Lab (CSL™) Hardware and Installation Manual* for hardware setup instructions.
	If you have both a CSL 4500b and PAS connected to the same computer, check that the switchbox has been turned to CSL. See the *Computerized Speech Lab (CSL™) Hardware and Installation Manual* for instructions on proper installation of the CSL with a switchbox.
No data is captured when using Multi-Speech with a pre-amplifier, after selecting Record	Ensure that the preamplifier is powered on and properly connected. If using PENTAX Medical model 3708 or 3710, see the Microphones and Preamps Hardware Installation and Maintenance Manual for more information on proper hardware connection.
	Check that the microphone is powered on and properly connected. If you are using the PENTAX Medical model 3706 microphone, ensure that a fresh battery is inserted. See the Microphones and Preamps Hardware Installation and Maintenance Manual for more information.

Problem	Possible Solutions
No data is captured when using Multi-Speech with a pre-amplifier, after selecting Record	Check that the default recording device and volume settings in the Sound Options accessed through the Windows Control Panel are properly selected. When using with a preamp such as PENTAX Medical model 3708, select "line in" input. See Microphones and Preamps Hardware Installation and Maintenance Manual for more information.
	If using the Windows Vista Operating System, ensure the default recording device has not been muted. Access the Sound control from the Control Panel. Then click the **Properties** button on the Line Input device, and go to the Levels Tab. Verify the device does not have a red No Sounds symbol, and the levels are at a midway mark.
No data is captured when using Multi-Speech with a Microphone Input (no preamplifier), after selecting Record. Microphone Input is not recommended.	Check that the microphone is powered on and properly connected. If you are using the PENTAX Medical model 3706 microphone, ensure that a fresh battery is inserted. See the Microphones and Preamps Hardware Installation and Maintenance Manual for more information.
	Check that the default recording device and volume settings in the Sound Options accessed through the Windows Control Panel are properly selected. When using with a standard audio card select "microphone." See the Microphones and Preamps Hardware Installation and Maintenance Manual for more information.
Data dropouts occur during capture or playback when using CSL 4500b or Visi-Pitch.	This can be caused by conflicts with other PCI devices. Remove all PCI devices except the PENTAX Medical device (PCIe sound card). Check to see if the dropouts still occur. If not, re-install the PCI devices one at a time to find the unfriendly card. If the dropout continues even with all other cards removed, contact the PENTAX Medical product technical support.

Appendix F. IPA Characters

F-1 Introduction

The CSL and Multi-Speech programs are capable of displaying characters of the International Phonetic Alphabet (IPA Symbols) on a transcription screen, as a means of annotating, describing, and identifying a speech waveform that appears on another display screen. The IPA transcription can also be printed along with the other screens.

The IPA font for use with CSL and Multi-Speech consists of 193 symbols, including consonant and vowel symbols, segmental diacritics, suprasegmental symbols, and transcription boundary markers. The basis for the font is the International Phonetic Alphabet (revised in 1993) as published in the *Journal of the International Phonetic Association*, Vol. 23, 1993. Key definitions have been assigned to 131 keyboard positions as a “default” keyboard for the IPA font. This is the number of keys available for assignment when using Multi-Speech or CSL in the “Key,” “Shift Key,” and “Alt Key” modes. Symbols, which have not been given a keyboard definition in the “default” keyboard, can be reassigned by the user to accommodate local convention, frequency of use of particular characters, preferred mnemonic placement, or ease of typing. In “Key” mode, 46 keys are available for assignment, excluding the semicolon (;) key that is already assigned a definition in CSL and Multi-Speech. In “Shift Key” mode, all 47 keys are available for assignment. In “Alt Key” mode, 38 keys are available for assignment. “Alt Key” positions which have no definitions and which, therefore, cannot be used for the IPA font include the *back accent* (` ~), *comma* (, <), *period* (. >), *slash* (/ ?), *semicolon* (; :), *quotation mark* (' "), *left square bracket* ([{), *right square bracket* (] }), and *backslash* (\ |) keys.

All current IPA vowel symbols and consonant symbols have been given “Key” or “Shift Key” definitions, and diacritics have been assigned largely to the “Alt Key” keyboard. This has been done by using the IPA number of each symbol or diacritic as set out in the *Journal of the International Phonetic Association*, Vol. 20 (1), 1990, and assigning it a keyboard code in MS-DOS format. Modifications to the IPA keyboard for use with Multi-Speech can also be made by referring to each IPA number symbol and replacing the current, pre-assigned number with the number of the new, desired symbol using the “Define Key” procedure. IPA symbols and their corresponding numbers and names, as well as their currently assigned keyboard locations in Multi-Speech are listed in the accompanying tables.

Symbols not assigned a location in the “default” IPA keyboard include more recently approved IPA symbols. Quite a few diacritics remain unassigned—tone marks, for instance—as their use (outside of a core set) will depend largely on local convention and user preference. The set of keys already defined can be altered or extended to include phonetic values required by the individual user. The one click symbol which was left out, for example, could be easily reinserted in the keyboard definitions by assigning its IPA number (178) to the “Shift 1” (!) key if the symbol now occupying that location is expendable. Alternatively, many keys in the “Ctrl Key” mode can also be defined as IPA characters if the user wishes to expand the set. In each symbol category, several non-IPA or former IPA characters have been included in the IPA font. In all cases, these are characters which can be identified with an IPA number and assigned a keyboard location if desired.

F-2 Computer Coding of the IPA

The declaration of the workgroup on Computer Coding of IPA Symbols and Computer Representation of Individual Languages recommends that a unique numerical equivalent and descriptive name be assigned for reference purposes to every symbol or diacritic used in current or earlier versions of the IPA. The logical phonetic organization of the IPA symbol chart is the basis for assigning the IPA number, the first digit of which indicates the category of the symbol. The 1nn series includes consonant symbols from the principal place-by-manner grid of the chart and from the Other Symbols section. The 2nn list includes former or alternative IPA consonant symbols (beginning with 201), and non-IPA consonant symbols that have been widely used in computer-coded systems (starting with 299 and working backwards). The 3nn series specifies vowels, most of which appear in the vowel quadrilateral (beginning with 301), and with former symbols numbered from 399 backwards. The 4nn series includes segmental diacritics (beginning with 401), with formerly used diacritics that no longer appear on the chart numbered from 499 backwards. The 5nn series includes suprasegmental symbols, from that section of the chart (beginning with 501), with previously specified tone marks numbered from 599 backwards. The 6nn series is reserved for assignment at a future date to symbols representing voice quality settings or pathological speech; and 7nn-8nn are also reserved for future specification. The 9nn series specifies control characters and escape sequences, designed to relate characters to each other in a string (for correct placement of diacritics, for example). The intention of the IPA number chart is to parallel the IPA symbol chart, making the locations and relationships of items explicit and unambiguous. For the present purposes of review and evaluation of the numbering scheme, the presentation of the IPA number chart and corresponding lists is intended to illustrate the relationships between symbols on the chart (and with those not shown but also numbered), and where overlap between categories can occur.

Symbols can now be listed with reference to their IPA number, and cross-referenced to symbol name. These reference lists can follow (1) chart order of appearance of the symbols, (2) quasi-alphabetical order of the symbol shapes themselves and (3) alphabetical order of the names of the symbols. The IPA number chart provides a visual map in chart order. The list of consonant/vowel symbols in chart/number order summarizes this sequence and includes the listing of the 2nn series and items of the 3nn series that are no longer on the chart. The list of consonant/vowel symbols in alphabetical order by symbol reproduces the compilation in Pullum and Ladusaw's *Phonetic Symbol Guide* (1986). Some modifications have been made to the names taken from the *Guide* as they appear here. It is the sentiment of the Computer Workgroup that in order to have an explicit system for referring to each character unambiguously, symbols need to be called something that is relatively nonphonetic in addition to having a number. Diacritics are listed, with illustrations as to usage, according to chart order. In addition, it is also possible to produce cross-referenced lists to consonant/vowel symbols and to diacritics according to alphabetical order by symbol name. All of these listings are proposed to constitute a part of *The IPA Handbook*.

Reference

Pullum, G.K. and W.A. Ladusaw, *Phonetic Symbol Guide*. Chicago: University of Chicago Press, 1986.

F-3 Consonant/Vowel Symbols

IPA Description	Glyph	IPA Number	Access Code
Lower-case P	□	101	112
Lower-case B	♌	102	098
Lower-case T	♦	103	116
Lower-case D	♎	104	100
Right-tail T	↘	105	255
Right-tail D	✰	106	234
Lower-case C	χ	107	099
Barred Dotless J	⇦	108	239
Lower-case K	κ	109	107
Lower-case G	♑	110	103
Lower-case Q	❑	111	113
Small Capital G	☝	112	071
Glottal Stop	📭	113	063
Lower-case M	❍	114	109
Left-tail M (at right)	✪	115	077
Lower-case N	■	116	110
Right-tail N	🖫	117	247
Left-tail N (at left)	✸	118	248
Eng	☠	119	078
Small Capital N	✈	120	178
Small Capital B	⇖	121	245
Lower-case R	❒	122	114
Small Capital R	☼	123	123
Fish-hook R	✿	124	082
Right-tail R	❁	125	125
Phi	☞	126	184
Beta	✌	127	066
Lower-case F	➚	128	102

IPA Description	Glyph	IPA Number	Access Code
Lower-case V	❖	129	118
Theta	❄	130	084
Eth	☟	131	068
Lower-case S	⬧	132	115
Lower-case Z	⌘	133	122
Esh	💧	134	083
Yogh	☪	135	090
Right-tail S (at left)	▪	136	167
Right-tail Z	🕐	137	189
C Cedilla	❷	138	067
Curly-tail J	☺	139	198
Lower-case X	☒	140	120
Gamma	✞	141	196
Chi	✠	142	088
Inverted Small Capital R	❸	143	210
Crossed H	⅄	144	240
Reversed Glottal Stop	✍	145	192
Lower-case H	h	146	104
Hooktop H	☝	147	250
Belted L	P	148	194
L-Yogh Digraph	☹	149	076
Cursive V	☜	150	086
Turned R	☐	151	168
Turned R, Right Tail	⌫	152	211
Lower-case J	♏	153	106
Turned M, Right Leg	⬀	154	229
Lower-case L	●	155	108
Right-tail L	⇨	156	241
Turned Y	◈	157	180
Small Capital L	😐	158	059

IPA Description	Glyph	IPA Number	Access Code
Hooktop B	🕓	160	186
Hooktop D	⬉	162	235
Hooktop Barred Dotless J	▫	164	215
Hooktop G	⬂	166	169
Hooktop Small Capital G	⬈	168	253
Turned W	🕐	169	227
Lower-case W	⬥	170	119
Turned H	🡐	171	231
Barred Glottal Stop	⌦	172	251
Small Capital H	⬋	173	075
Barred Reversed Glottal Stop	🕚	174	185
Hooktop Heng	k	175	238
Bull’s Eye	l	176	135
Exclamation Point	🖫	178	151
Turned Long-leg R	q	181	228
Curly-tail C	②	182	254
Curly-tail Z	⬄	183	252
Lower-case I	♓	301	105
Lower-case E	♏	302	101
Epsilon	☜	303	069
Lower-case A	♋	304	097
Cursive A	✌	305	065
Open O	⚐	306	141
Lower-case O	□	307	111
Lower-case U	◆	308	117
Lower-case Y	⍓	309	121
Slashed O	🏱	310	079
O-E Digraph	✿	311	191
Small Capital O-E Digraph	🙵	312	175
Turned Cursive A	①	313	129

IPA Description	Glyph	IPA Number	Access Code
Turned V	🕘	314	195
Ram's Horns	✞	315	070
Turned M	✶	316	181
Barred I	🡅	317	246
Barred U	➔	318	172
Small Capital I	✋	319	073
Small Capital Y	✡	320	089
Upsilon	✞	321	085
Schwa	★	322	171
Barred O	🕔	323	080
Turned A	➊	324	140
Ash digraph	⍉	325	081
Reversed Epsilon	↗	326	206
Undotted I	✋	394	034
Closed Reversed Epsilon	®	396	207
Reversed E	°	397	130
Dotless J	—		190
Superior m	⊃		201
Superscript Eng	™		212
Superscript left-tail N (at left)	⊄		203

F-4 Segmental Diacritics

IPA Description	IPA	Number	Access Code
Apostrophe		401	039
Under-ring (o-width)	☎	402	056
Under ring (i-width)	✆	402	165
Over-ring (o-width)	☎	402	042
Over ring (i-width)	✆	402	161
Subscript Wedge	✁	403	164
Superscript H	¶	404	072
Subscript Umlaut (o-width)	🕓	405	045
Subscript Umlaut (i-width)	🕓	405	208
Subscript Tilde	🕮	406	188
Subscript Seagull	∇	407	209
Subscript Bridge	º	408	053
Inverted Subscript Bridge	»	409	176
Subscript Square	🗐	410	054
Subscript Plus (o-width)	¿	413	043
Subscript Plus (I-width)	¿	413	177
Under-bar (o-width)	🗎	414	061
Under-bar (i-width)	🗎	414	173
Umlaut	🡩	415	095
Over-cross	🖃	416	126
Right Hook	Ô	419	213
Superscript W	⌖	420	087
Superscript J	☞	421	074
Superscript Gamma	⮘	422	236
Superscript Reversed Glottal Stop	M	423	179
Superscript Tilde (o-width)	❧	424	041
Superscript Tilde (i-width)		424	226
Superscript N	Ë	425	060

IPA Description	IPA	Number	Access Code
Superscript L	●	426	058
Corner	í	427	124
Superimposed Tilde	~	428	242
Raising Sign (o-width)	⦿	429	051
Raising Sign (i-width)	⦿	429	163
Lowering sign (o-width)	⌛	430	052
Lowering sign (i-width)	⌛	430	162
Syllabicity Mark	'	431	096
Subscript Arch (o-width)	ˆ	432	057
Subscript Arch (i-width)	ˆ	432	187
Top Tie Bar	○	433	131
Comma	📪	491	044
Vertical Stroke (Superior)	✂	501	200
Vertical Stroke (Inferior)	♊	502	199
Length Mark	á	503	249
Half-length Mark	â	504	062
Breve (o-width)	✉	505	040
Breve (i-width)	✉	505	225
Period	.	506	046
Vertical Line	☙	507	150
Double Vertical Line	④	508	132
Bottom Tie Bar	◎	509	237
Upward Diagonal Arrow	⓿	510	204
Downward Diagonal Arrow	⌧	511	205
Double Acute Accent (o-width)	♉	512	033
Double Acute Accent (i-width)	♉	512	218
Double Acute Accent (high o-width)	♉	512	136
Double Acute Accent (high i-width)	♉	512	137
Acute Accent (o-width)	✎	513	064
Acute Accent (high o-width)	✎	513	219

IPA Description	IPA	Number	Access Code
Acute Accent (i-width)	✐	513	143
Acute Accent (high i-width)	✐	513	144
Macron (o-width)	⊖	514	035
Macron (high o-width)	📫	514	220
Macron (i-width)	⊖	514	147
Macron (high i-width)	📫	514	148
Grave Accent (o-width)	”	515	036
Grave Accent (high o-width)	”	515	221
Grave Accent (i-width)	”	515	152
Grave Accent (high i-width)	”	515	153
Double Grave Accent (o-width)	✆	516	037
Double Grave Accent (high o-width)	✆	516	222
Double Grave Accent (i-width)	✆	516	157
Double Grave Accent (high i-width)	✆	516	158
Down Arrow	☎	517	155
Up Arrow	❧	518	139
Extra-high Tone Bar	⑨	519	138
High Tone Bar	❺	520	145
Mid Tone Bar	❾	521	149
Low Tone Bar	☙	522	154
Extra-low tone Bar	·	523	159
Wedge (o-width)	✁	596	038
Wedge (i-width)	✁	596	224
Wedge (high o-width)	✁	596	244
Wedge (high i-width)	✁	596	243
Circumflex (o-width)	👓	597	094
Circumflex (i-width)	👓	597	223
Circumflex (high o-width)	👓	597	233
Circumflex (high i-width)	👓	597	230
Left Square Bracket	☯	901	091

IPA Description	IPA	Number	Access Code
Right Square Bracket	☸	902	093
Right Bar 15	⑩		232
Right Bar 51	❻		134
Right Bar 35	•		216
Right Bar 13	❿		128
Right Bar 53	ÿ		133
Right Bar 31	☙		217
Backward Slash	\		092
Forward Slash	/		047
Hyphen Dash	–		214

Appendix G. Predefined Keys

This Appendix provides a complete list of the predefined keyboard combinations that can be used to execute program operations.

Primary menu options are listed in bold, followed by a semicolon and submenu options.

Key	Menu Item	Description
F1	**Help**: Open Help	Opens Help documentation.
F2	**Window**: Purge Active Window	Clears the active window and removes any associated data.
F3	**Speak**: All Data	Starts audio output of all signal associated with active window.
F4	**Speak**: Selected Data	Starts audio output of signal associated with selected region in active window.
F9	**Window**: Information on Active Window	Displays summary information about the most recent data placed in active.
F12	**File**: New (Record)	Purges the active window and captures a new signal.
Shift+F1	**IPA**: Load IPA Symbols to Keyboard	Configures keyboard for typing IPA symbols into window containing waveform.
Shift+F2	**IPA**: Restore Keyboard to Normal	Removes the IPA keyboard configuration.
Alt+F4	**File**: Exit	Exits back to Windows.
Alt+A	**View**: All Data	Displays all graphic data associated with active window.
Alt+C	**View**: Start to Cursor	Displays graphic data from start of data to cursor location in active window.
Alt+E	**View**: Cursor to End	Displays graphic data from cursor location to end of data in active window.
Alt+L	**Window**: Link Windows, Link to Source Window	Links cursor movement, selection and display in active window to source.
Alt+M	**View**: Between Data Mark and Cursor	Displays graphic data between green marking cursor and red data cursor.
Alt+R	**Analysis**: Produce Numerical Results	Displays numerical results of last analysis in active, with print/save options.

Key	Menu Item	Description
Alt+S	**Analysis**: Compute Result Statistics	Gets stats of last analysis results in active, with print/save options.
Alt+T	**View**: Between Tags Around Cursor	Displays waveform from tag preceding to tag following cursor in active window.
Alt+U	**Window**: Link Windows, Unlink Active Window	Unlinks active window from any other windows it was previously linked to.
Alt+V	**View**: Selected Data	Displays graphic data in selected region of active window.
Alt+W	**Window**: Select Active Window as Source	Makes active window the signal source for subsequent analysis or editing.
Shift+Del	**Edit**: Remove Selection Cursors	Removes selection cursors from the data in active and linked windows.
PgUp	**Window**: Activate Next Window	Activates the previous window in a list of available windows.
PgDn	**Window**: Activate Previous Window	Activates the next window in a list of available windows.
Ctrl+Home	**View**: Put Previous Plot on Top	If multiple plots in active, brings previous plot to front.
Ctrl+End	**View**: Remove Current (Top) Plot	If multiple analysis plots in active, deletes the plot that is on top.
Ctrl+A	**Edit**: Select All Data	Selects all data in active and linked windows.
Ctrl+C	**Edit**: Copy Signal to Clipboard	Copies signal data in the active window to the clipboard.
Ctrl+N	**Window**: Open New Window	Creates new window over active window, with attributes of active.
Ctrl+O	**File**: Open (Load)	Purges the active window and loads new waveform data from a file.
Ctrl+P	**File**: Print/Save Graphic Images, Print Full Screen Image	Accesses dialog box for sending graphic image of the full screen to the selected printer.
Ctrl+S	**File**: Save	Saves the waveform data in the active window to a file.
Ctrl+V	**Edit**: Paste Signal from Clipboard	Purges the active window and loads signal data from the clipboard.
Ctrl+Z	**Edit**: Undo Last Edit in Active	Undoes last edit made to the data in the active window.

Key	Menu Item	Description
Shift+Ctrl+P	**File**: Print/Save Graphic Images, Print Active Window Image	Prints the image in the active window using the resolution of the selected printer.
Shift+Ctrl+S	**File**: Print/Save Graphic Images, Save Active Window Image	Saves the image in the active window to a graphics file, with user-selectable resolution.

The second table lists the keyboard shortcuts that can be used to move the data cursor and perform similar operations.

Key	Description
Home	Moves the data cursor in the active window to the start of the displayed data.
End	Moves the data cursor in the active window to the end of the displayed data.
Left	Moves the data cursor in the active window one pixel to the left.
Right	Moves the data cursor in the active window one pixel to the right.
Ctrl+Left	Moves the data cursor in the active window ten pixels to the left.
Ctrl+Right	Moves the data cursor in the active window ten pixels to the right.
Up	Moves data cross-hair up one pixel in spectrogram and formant displays.
Down	Moves data cross-hair down one pixel in spectrogram and formant displays.
Shift+Up	Highlights next frame on z-axis in waterfall display.
Shift+Down	Highlights previous frame on z-axis in waterfall display.
Ins	Opens dialog box for defining keys to execute commands and for showing current definitions.
Num+	Places a data mark at the current cursor location in the active window.
Num-	Selects all data in active and linked windows.

Appendix H. Mise en Garde et Precautions

Avertissement

Vous devriez lire et comprendre les directives comprises dans le présent manuel avant d'exécuter toute intervention à l'aide du CSL et Multi-Speech. Tout manquement à cet effet pourrait blesser le patient ou endommager l'instrument.

Avertissement

Des messages d'avertissement vous indiqueront quelles conditions pourraient entraîner des blessures graves, voire la mort.

Avertissement

Pour éviter les risques de choc électrique, connecter cet équipement à une source d'alimentation protégée par une mise à la terre.

Avertissement

Pour réduire le risque d'incendie et de choc électrique, ne pas exposer l'équipement électrique à l'humidité et à la poussière.

Avertissement

Cet équipement ne doit pas être utilisé en présence d'un mélange d'anesthésique inflammable et d'air, d'oxygène ou d'oxyde nitreux.

Avertissement

Il est recommandé de porter de l'équipement de protection approprié (gants, vêtements imperméables souples, masque et protection respiratoire) pendant l'exécution des interventions de retraitement.

Mise en garde

Les messages de mise en garde vous indiquent des problèmes pouvant entraîner des blessures mineures ou modérées ou des dommages.

Mise en garde

Ne pas modifier cet équipement sans avoir l'autorisation du fabricant à cet effet.

Mise en garde

Ce produit ne contient aucune pièce pouvant être réparée. Ne pas démonter l'unité.

Mise en garde

Les accessoires branchés au port USB doivent être homologués selon la norme IEC 60950-1 Équipement informatique – Sécurité – Partie 1 : Exigences générales pour l'équipement de traitement des données et IEC 60601-1 Équipement médical électrique - Partie 1 : Exigences générales pour la sécurité pour l'équipement médical.