

Sound Power Plus

Operator Manual

Worldwide Technical Support and Product Information

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About This Manual

This manual provides an overview of Sound Power Plus. It includes information about configuring your software and using it to take acoustic measurements. Sound Power Plus is designed for use with Windows 2000/NT/Me/9x.

Conventions

The following conventions appear in this manual:

»

The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.



This icon denotes a tip, which alerts you to advisory information.



This icon denotes a note, which alerts you to important information.

bold

Bold text denotes items that you must select or click on in the software, such as menu items and dialog box options.

italic

Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept.

monospace

Text in this font denotes text or characters that you should enter from the keyboard. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, operations, variables, filenames, and extensions.

Related Documentation

The following documents contain information that you might find helpful as you read this manual:

- ANSI S1.13., *Measurement of Sound Pressure Levels in Air*. ANSI standards are available through the American National Standards Institute website at www.ansi.org
- ECMA-74. ECMA standards are available through the ECMA website at www.ecma.ch

- ISO 3744, 3745, and 7779. ISO standards are available through the International Organization for Standardization website at www.iso.ch
- Nobile, Matthew A. and Gordon R. Bienvenue. *A Procedure for Determining the Prominence Ratio of Discrete Tones in Noise Emissions*. Institute of Noise Control Engineering (INCE) Noise-Con 91 proceedings. This document is available from INCE at www.ince.org

Introduction to Sound Power Plus

National Instruments Sound Power Plus automates the acquisition and analysis of computer and business equipment noise emission measurement data. With Sound Power Plus, you can acquire data from multiple sources simultaneously using as many as five National Instruments Dynamic Signal Analysis (DSA) devices, dramatically increasing the speed and efficiency of your application.

Sound Power Plus implements the acoustic measurement procedures defined in ISO 7779 and ECMA-74. In addition, Sound Power Plus supports a number of user-configurable options that allow you to implement several other basic sound power and sound pressure level measurement standards, such as ISO 3744, ISO 3745, ISO 6926, ANSI S12.34, and ANSI S12.35. You can easily adapt the software to implement a number of equipment test codes that require measurement of sound power and sound pressure levels of various devices.

System Requirements

Your system must meet the following requirements to run Sound Power Plus:

- 133 MHz Pentium or higher microprocessor
- Microsoft Windows 2000/NT/Me/9x
- 64 MB RAM
- 50 MB available hard drive space.
- National Instruments NI 455x DSA device
- LabVIEW 6.0 or higher
- National Instruments Real-Time Octave Analysis Software, version 1.2 or higher
- NI-DAQ 6.9.1 or higher

- A National Instruments GPIB device, if you plan to use a GPIB-based multiplexer
- Microsoft Excel 97 or 2000 (required to export data, import microphone sensitivity and frequency response data, and execute source code)

If you have purchased the Sound Power Plus Developer Software package, you must have the following software components to take advantage of the editable source code feature:

- LabVIEW Full Development System for Windows or LabVIEW Professional Development System for Windows
- National Instruments LabVIEW Sound and Vibration Toolset for Windows, version 1.0 or higher

Program Overview

Sound Power Plus is a LabVIEW application.



Note Owners of a source code license and the appropriate LabVIEW applications can access the source code to modify the software to fit their particular laboratory or test needs.

Test Routines

Sound Power Plus implements the following basic test routines:

- Sound power level measurement in a free field or free field over reflecting plane test environments
- Sound pressure level measurements, including sound quality analysis using prominent tone and impulsive noise analysis

Measurement Devices

The software uses at least one or as many as five National Instruments NI 4551 or NI 4552 DSA boards as measurement devices.

Drivers

Sound Power Plus includes drivers for several external devices commonly used to support automated measurement of computer noise emissions, such as microphone multiplexers. These drivers permit rapid configuration to accommodate a wide variety of laboratories. Appendix C, [Supported Drivers](#), lists the drivers supported by Sound Power Plus.

Data Files

The software can export data to three types of files: binary files, Microsoft Excel files, and text files. The **Save Measurement** function generates a binary data file for each test serial number. This file contains test documentation, measurement configuration information, sound power data, and sound pressure level data. The **Export to Excel** function exports all test information into an Excel template file. The **Export to Text File** function exports all or selected test information into a text file so that you can apply your own data analysis techniques to the measured data.

The program also creates several other files that contain instrument configuration, measurement configuration, and calibration data. These files can be saved and loaded into the program, which lets you quickly reconfigure standard configurations. For more information, refer to Appendix B, *Program and Data Files*.

User Interface and General Program Layout

Figure 1-1 illustrates the Sound Power Plus user interface, which consists of a three-window screen layout.

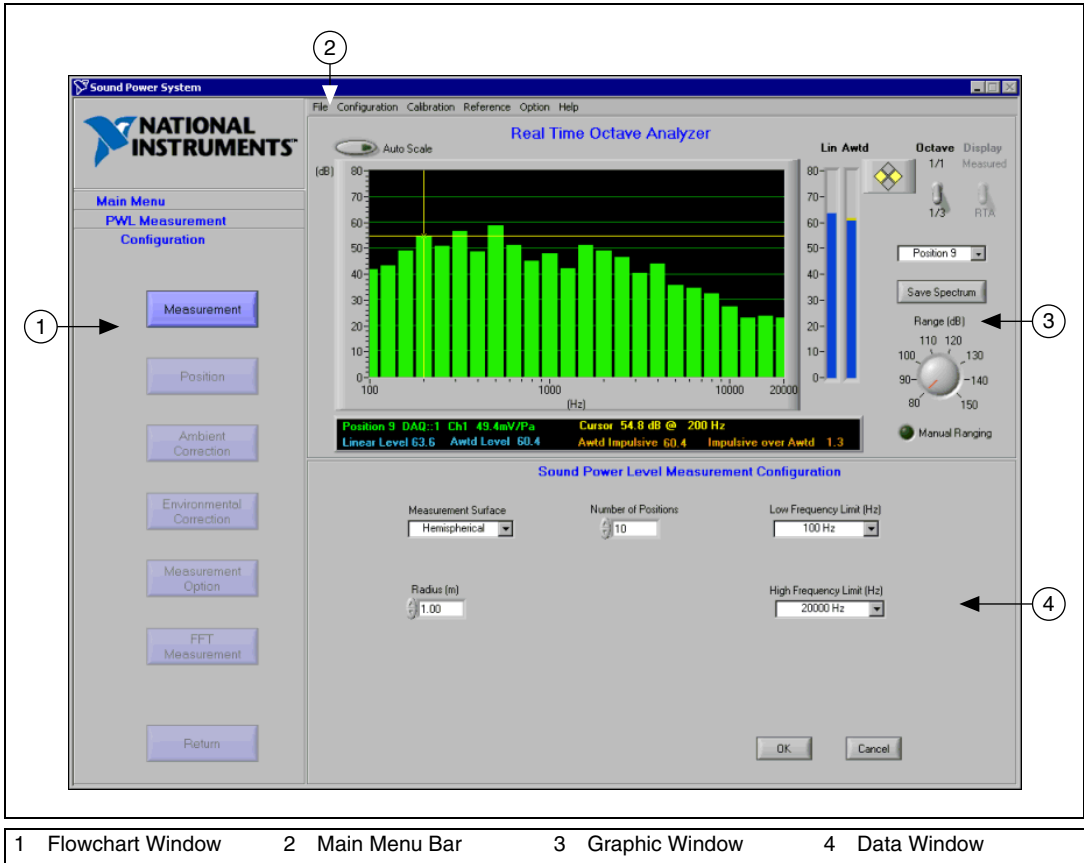





Figure 1-1. Sound Power Plus User Interface

Flowchart Window

The flowchart window at the left side of the screen guides you through the configuration, test documentation, calibration, and measurement routines. By clicking a button, you sequentially execute each step necessary to complete a routine. Clicking a flowchart button either opens a data window or activates another flowchart.

Flowchart buttons are color-coded to describe the current status of each step. The following table lists each button color and its corresponding status.

Table 1-1. Flowchart Button Display States

Display State	Status
	Control is available. All previous required steps are complete.
	Control is unavailable. Previous required steps are not complete, or current action does not allow use of this control.
	All required actions for this step are complete.

The status of each button is updated either when you complete a step (by clicking **OK** in a data window) or when you load data that satisfies the step.

Click the **Return to Main Menu** button to exit the current flowchart routine and return to the main menu.

Data Window

The data window at the bottom of the screen contains controls for setting up configurations and taking measurements. The controls let you select positions to be measured, start measurements, and accept the data. Measurement results are displayed in data tables located in this window.

When the main menu flowchart is active, the data window shows the data and configuration files currently in use by the program. The following files are displayed:

- **Measurement**—The current measurement data file, if the current measurement has been saved. If the current measurement data has not been saved, this field is blank.
- **Calibration**—The current calibration data file, if the current calibration data has been saved. If the current calibration data has not been saved, this field is blank.
- **Instrument Configuration**—The current instrument configuration file. Initially, Sound Power Plus displays the default instrument configuration file. This file name will change when the instrument configuration settings are saved to a named file or when a named file is loaded.
- **PWL Configuration**—The current sound power level measurement configuration file. Initially, Sound Power Plus displays the default sound power level configuration file. This file name will change when the sound power level configuration settings are saved to a named file or when a named file is loaded.
- **SPL Configuration**—The current sound pressure level measurement configuration file. Initially, Sound Power Plus displays the default sound pressure level configuration file. This file name will change when the sound pressure level configuration settings are saved to a named file or when a named file is loaded.

Graphic Window

The graphic window at the top of the screen automatically updates based on the routine you are executing:

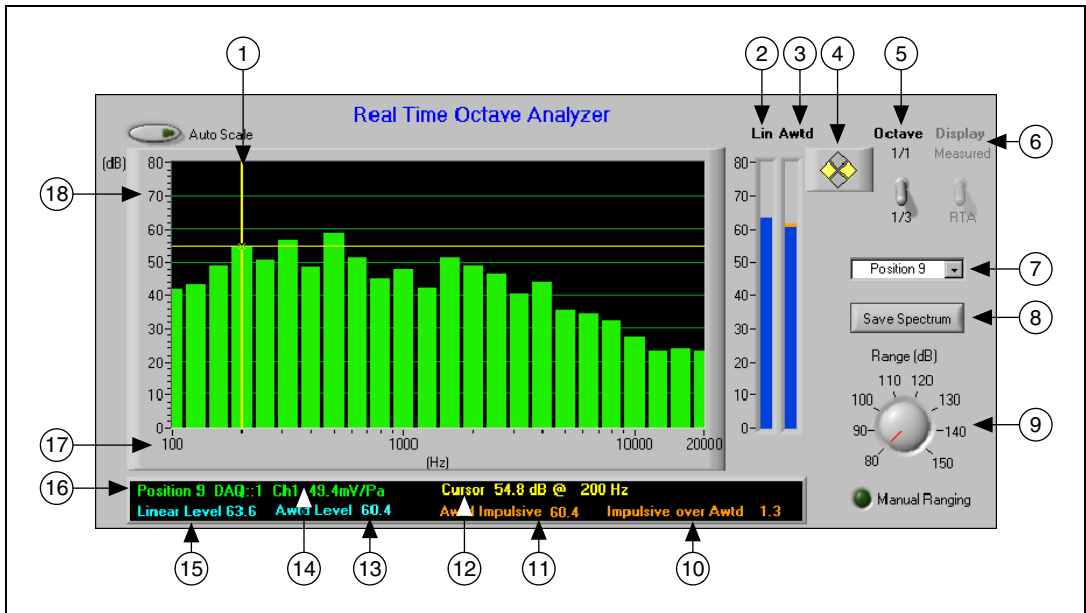
- During ambient and source sound pressure level measurement routines, this window becomes a 1/1-octave band or 1/3-octave band Real Time Analyzer (RTA) display and contains controls associated with the RTA.
- During the Fast Fourier Transform (FFT) source sound pressure level FFT measurement in the sound power level routine, or during prominent tone analysis in the operator/bystander sound pressure level routine, this window becomes an FFT analysis display and contains controls associated with the FFT analyzer.
- During measurement review routines, this window becomes a test results display and contains information about the results and controls

associated with the test results display and the reference spectrum features.

The following sections describe the graphic window display modes in more detail.

RTA Display

The RTA display consists of a series of indicators for each 1/1-octave band or 1/3-octave band. When not performing a particular measurement, these indicators display the instantaneous “slow” sound pressure level (SPL). Figure 1-2 illustrates the parts of an RTA display.



1 RTA Cursor	7 Position Ring	13 Current Awt'd SPL
2 Overall Linear SPL	8 Save Reference Spectrum	14 Nominal Sensitivity
3 Overall Awt'd SPL	9 Input Range Control	15 Current Linear SPL
4 Cursor Controls	10 Offset of Awt'd From Impulsive	16 Input Source
5 1/1 and 1/3 Octave Switch	11 Current Awt'd Impulsive SPL	17 Frequency Axis
6 Display Switch	12 Current SPL at Center Frequencies	18 Sound Level Axis

Figure 1-2. Sample RTA Display Window

The RTA display can display 1/1-octave spectrums. Each band level is the sum of three 1/3-octave bands within the 1/1-octave band. Use the switch to alternate between 1/1- and 1/3-octave bands. The RTA display includes two overall level indicators. The left overall level indicator displays the instantaneous slow linear SPL. The right overall indicator displays the

instantaneous slow A-weighted (AwtD) SPL. The AwtD display contains an additional orange indicator that displays the impulse, A-weighted SPL.

The RTA display can display a frequency range of 25 to 20,000 Hz, depending on the frequency range you configure in the sound power or sound pressure level measurement configuration.

Alphanumeric Indicators

A series of alphanumeric indicators display the following information:

- The input source (position, data acquisition board and channel number) for the current measurement, followed by the microphone sensitivity (in mV/Pa)
- The current SPL in the frequency band selected by the cursor, followed by the center frequency of the selected 1/1- or 1/3-octave band
- The current linear SPL
- The current AwtD SPL
- The current AwtD impulsive SPL
- The amount by which the current AwtD impulsive sound pressure level exceeds the current AwtD sound pressure level

RTA Cursor

A movable cursor lets you select any band for the alphanumeric display band level. Use the yellow arrow controls at the upper-right corner of the RTA display to move the cursor to the desired band and read the selected measurement in the alphanumeric display.

RTA Controls

The RTA display is automatically configured based on the frequency range you set in the sound power or sound pressure level measurement configuration. To change the upper and lower limits of the level axis, double-click the upper or lower limit levels and edit the value displayed. The axis automatically rescales.

The RTA display includes the following controls:

- **1/1 and 1/3 Octave**—Use this switch to toggle the spectrum display between 1/1-octave and 1/3-octave bands.



Note The octave band feature only allows the display of the current RTA data in 1/1-octave bands. Data stored in Sound Power Plus native file format or exported by Sound Power Plus is in 1/3-octave bands.

- **Display**—Select one or more measured positions in the data window to enable the display switch. The RTA display toggles between the measured octave spectrum and free running octave spectrum. If you select more than one measured spectrum and the display switch is set to **Measured**, RTA displays only the first selected position.



Note If the display control is set to **RTA**, the RTA displays the spectrum of the current position selected in the **Position** control.

- **Position**—Use the drop-down list box to select the position you want to monitor in RTA. The options available in this list box are determined by the type of measurement you select.
- **Range**—This dial sets the input range of the instrument. If auto-ranging is enabled, as shown in the [Auto-Ranging Configuration](#) section in Chapter 2, [Installation and Configuration](#), this dial is not available.
- **Save Spectrum**—Click this button to save the current sound pressure level spectrum into a reference spectrum file. A dialog box prompts you to enter a file name for the reference spectrum.

FFT Display

The FFT display can graphically display the results of the FFT at one or more selected positions and the average FFT, if selected. Figure 1-3 illustrates the parts of an FFT display.

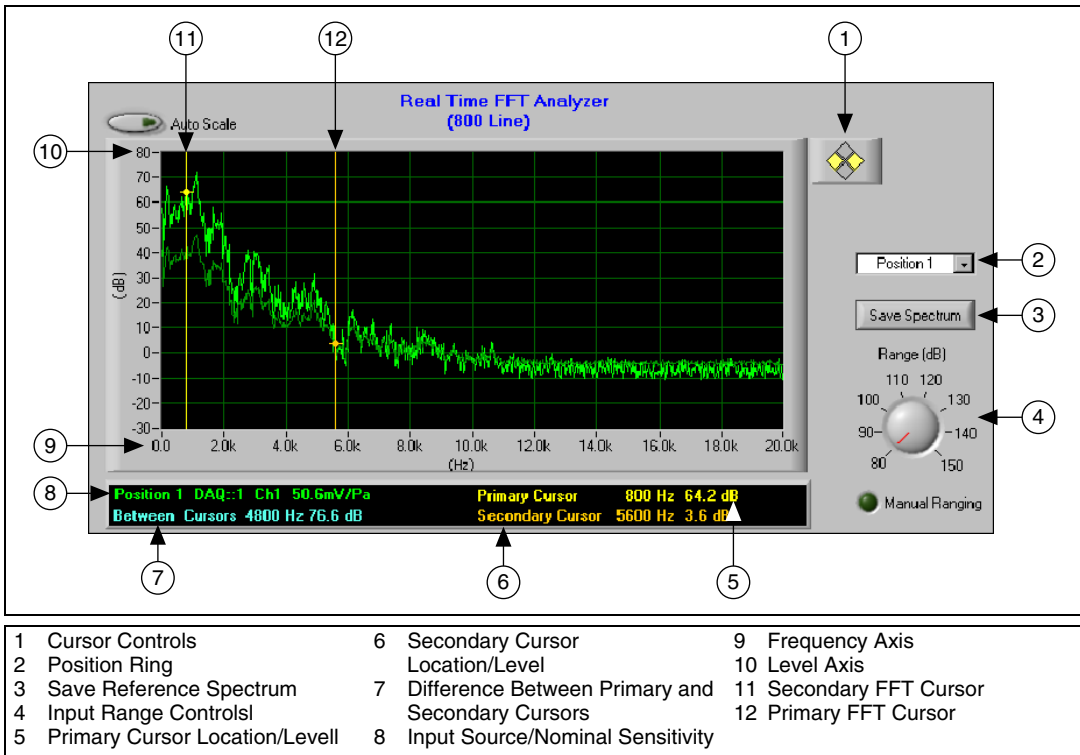


Figure 1-3. Sample FFT Display Window

Sound Power Plus acquires and displays an 800-line FFT during the sound power source FFT sound pressure level routine and a 12,800-line FFT during the prominent tone analysis routine. The frequency range is determined by the FFT measurement configuration.

Alphanumeric Indicators

A series of alphanumeric indicators display the following information:

- The source of the current FFT spectrum being acquired (position, data acquisition channel, and channel number)
- The calibrated input sensitivity of the input device
- The frequency and level at the primary (yellow) cursor location

- The frequency and level at the secondary (orange) cursor location
- The frequency difference between the two cursors and total energy between cursors



Note When multiple spectra are being displayed, the total energy between the cursors is only displayed if both cursors are selected on the same spectrum.

FFT Cursors

Two movable cursors allow you to select any two frequencies in the FFT spectra. Use the yellow arrow controls at the upper-right corner of the FFT display to move the cursor to the desired frequency and read the selected level and frequency in the alphanumeric display.

When the two cursors select frequencies on the same spectrum, the alphanumeric display provides an indicator for the total energy between the cursors. When the two cursors select frequencies on different spectra, only the frequency difference between the cursors is displayed.

If you want to change to another FFT spectrum, click the crosshairs on the cursor and drag the dot to the spectrum and frequency you want. If the crosshairs on the cursor are lost and the digital display shows NaN (Not a Number), the current cursor is locked on a spectrum that is not available. Click the up and down arrow controls at the upper-right corner of the FFT display until a number is displayed for the current cursor.

FFT Controls

The FFT display is automatically configured based on the frequency range you configure in the sound power or sound pressure level measurement configuration. To change the upper and lower limits of the level axis, double-click the upper or lower limit levels and edit the value displayed. The axis automatically rescales.

The FFT display includes the following controls:

- **Position**—Use the drop-down list box to select the positions you want to measure and display in the FFT Analyzer. This control has no effect when you check **Display Selected** Control in the Source FFT Measurement window.
- **Range**—This dial sets the input range of the instrument. If auto-ranging is enabled, this dial is not available. Learn more about auto-ranging in Chapter 2, [Installation and Configuration](#).

- **Save Spectrum**—Click this button to save the currently displayed FFT spectrum to a reference spectrum. A dialog box prompts you to enter a file name.

Test Results Display

During the review routine, the graphic window becomes a test results display. Figure 1-4 illustrates the parts of a test results display.

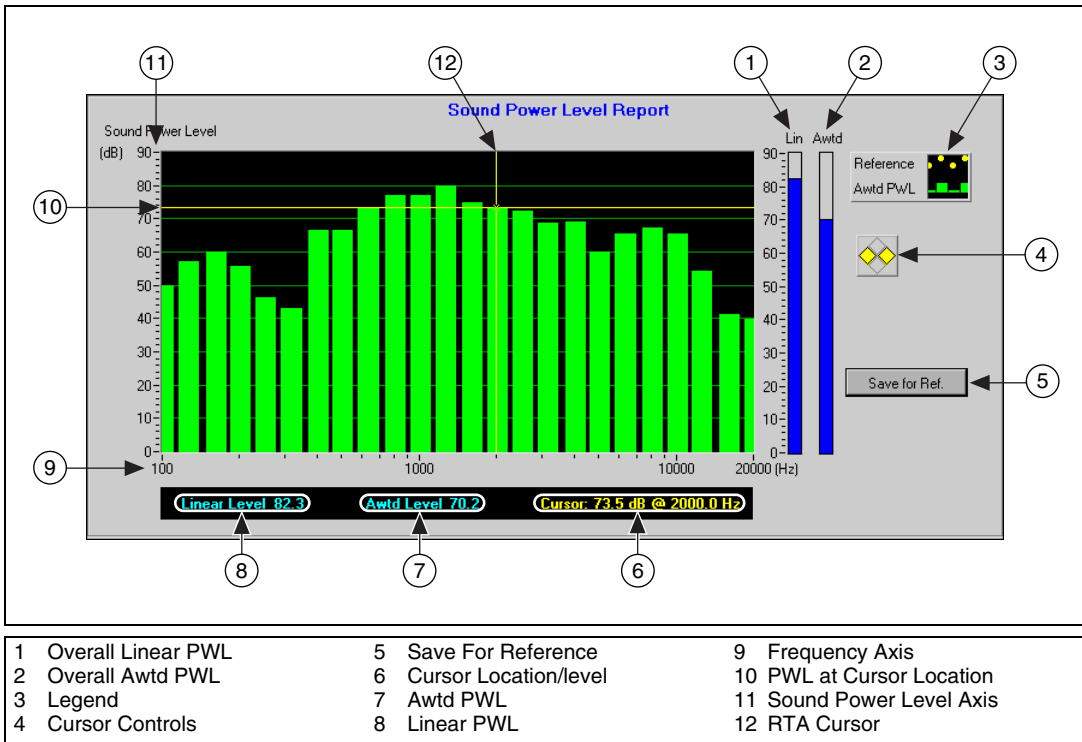


Figure 1-4. Sample Test Results Window (PWL Shown)

Alphanumeric Indicators

A series of alphanumeric indicators display the following information:

- The linear sound power level
- The AwtD sound power level
- The sound power level at the current cursor location and the frequency at the current cursor location

Test Results Cursor

A movable cursor lets you select any 1/3-octave band for the sound power level and frequency to display in the alphanumeric indicators.

Test Results Display Controls

The test results display is automatically configured based on the frequency range you configure in the sound power level measurement configuration. To change the upper and lower limits of the level axis, double-click the upper or lower limit levels and edit the value displayed. The axis automatically rescales.

Save Spectrum—Click this button to save the current sound power level result as a reference spectrum. A dialog box prompts you to enter a file name. If you want the spectrum to appear each time you display a sound power level result, save the spectrum in the file named `Ref_Sound Power Level_Default.ReP`.

Main Menu Bar

The main menu bar, located at the top of the Sound Power Plus interface, is always visible and active. Use this menu bar to perform the following tasks:

- Save and load measurement data files
- Save and load calibration data files
- Save, load, and edit instrument and measurement configuration files

File Menu

Commands on the **File** menu control the saving and loading of measurement data. From this menu, you can do the following tasks:

- Create a new data file using the **New Measurement** command
- Load a previous measurement using the **Load Measurement** command
- Save the current measurement using the **Save Measurement** command
- Change the default measurement data file directory using the **Change Directory** command
- Exit the program using the **Exit** command

Configuration Menu

Commands on the **Configuration** menu let you load, save, create, and edit instrument and measurement configuration files.

- Use the **Load** options to load a custom or default configuration file.
- Use the **Save** options to save a custom or default configuration file.
- Use the **Settings** options to create and edit configuration files and configure auto ranging.

You can also configure auto-range settings from this menu.

Calibration Menu

The **Calibration** menu provides tools for loading and saving calibration data and for changing system calibration settings.

Reference Menu

The **Reference** menu provides tools for loading and editing the system reference spectrum.

Option Menu

The **Option** menu provides a tool for maintaining the system password.

Help Menu

The **Help** menu lets you access information about Sound Power Plus and open the Sound Power Plus online help using the following controls:

- **Show Help**—Displays the Sound Power Plus online help
- **About**—Displays information about the version of Sound Power Plus

Installation and Configuration

This chapter describes how to install Sound Power Plus and configure your instruments and measurements.

Installation

Follow these instructions to install your Sound Power Plus software.

Configure Windows Settings

Make sure the settings on your computer match these settings before you install Sound Power Plus:

- Set your screen resolution to at least 1024 × 768 using at least 256 colors.
- Set your system to display small fonts.
- Make sure that the **Always on top** option in the Windows taskbar properties is not selected.

Install the Hardware

You must have at least one NI 4551 or NI 4552 DSA device installed on your computer to use Sound Power Plus. Also, make sure that you have National Instruments NI-DAQ 6.9.1 or higher installed on your system.

To ensure that the device and instrument driver are properly installed, follow these instructions to install each of your NI 4551 or NI 4552 devices:

1. Power off your system and unplug the power cord from your PC.
2. Install each DSA device in a full-length PCI slot.



Tip For detailed installation instructions, refer to the documentation included in your National Instruments hardware kit.

3. Replace the power cord and boot the system. The computer automatically detects new hardware.

4. Verify your installation:
 - a. Open **Measurement & Automation Explorer** (MAX) from the icon on your desktop.
 - b. Expand **Devices and Interfaces** in the MAX configuration tree.
 - c. Verify that all of your DSA devices are listed beneath **Devices and Interfaces**.

Install the GPIB Board

If you plan to use a GPIB-based multiplexer, make sure you have the appropriate GPIB board installed in your computer with the appropriate drivers. Refer to the documentation that came with your board for detailed installation and configuration instructions. Follow these steps to install your GPIB board:

1. Power off your system and unplug the power cord from your PC.
2. Install the GPIB board in a free PCI slot.
3. Replace the power cord and boot the system. The computer automatically detects new hardware.
4. On the **GPIB Configuration** screen, select the following options:
 - a. Set GPIB to 0.
 - b. Select **Board** and set **Board Type** to PCI-GPIB.
5. Click **Configure**.
6. Verify your installation:
 - a. Open **Measurement & Automation Explorer** (MAX) from the icon on your desktop.
 - b. Expand **Devices and Interfaces** in the MAX configuration tree.
 - c. Verify that the GPIB device is listed beneath **Devices and Interfaces**.

Install the BNC 2140 Breakout Box

Follow these instructions to install the BNC-2140 breakout box:

1. Locate the SHC68-C68-A1 analog cable that was included in your hardware kit.
2. Plug one end of the SHC68-C68-A1 cable into the 68-pin connector on the BNC-2140. Insert the other end of the cable into the 68-pin connector on your DSA device.
3. Tighten the jackscrews finger-tight on both ends of the cable, and reboot your computer.

4. You must manually configure the BNC-2140 by setting the channel switches:
 - a. Set all switches to **SE** (Single Ended).
 - b. Turn Integrated Circuit Piezoelectric (ICP®) **Off** (main and individual), unless you are using ICP microphones.

Install the Sound Power Plus Software

1. Close any open programs.
2. Insert the Sound Power Plus CD into your CD drive.
3. An autorun file launches to begin the Sound Power Plus installation. If this file does not launch automatically, start the installation manually by running `setup.exe` from the setup folder.
4. Follow the instructions on the screen to complete the installation.

Configuration

The rest of this chapter describes how to configure your instruments and measurements. You can provide configuration data to Sound Power Plus by loading the configuration information from a file or entering new data directly into Sound Power Plus.

Load a Configuration File

Select **Configuration»Load** to load instrument, sound power measurement, and sound pressure measurement configuration files. You must create configuration files using the **Configuration»Save** menu, and save those files in Sound Power Plus native format. Sound Power Plus does not check the compatibility of the loaded configuration files and the hardware in your system. If your configuration file is not compatible with your hardware, you will receive an error message when you start a measurement. Check file compatibility under **Configuration»Setting»Configuration Functions**.

You can also load settings for instrument, PWL measurement, or SPL measurement configurations. Select **Configuration»Load»Default»All** if you want to load the default files for all instrument and measurement configuration data.



Note Sound Power Plus displays the current instrument, sound power level, and sound pressure level configuration files in the data window when the main program menu is active in the flowchart window.

Enter New Configuration Data

Select **Configuration»Settings** to create or edit instrument, PWL measurement, SPL measurement, or auto-ranging configuration settings. Selecting this option activates the password entry dialog box. You must have the correct password to edit and save new settings. If the correct password is not entered, you can only browse, but not change, the current settings.

Saving Configuration Data

Select **Configuration»Save** to save any current instrument, PWL measurement, or SPL measurement configuration settings. Select **Configuration»Save»Default»All** if you want to save the current instrument and measurement configuration data into each of the three system default configuration files. A dialog box prompts you to enter the name of the file, and the file is then saved in the Sound Power Plus native file format.



Note Default files load each time you launch Sound Power Plus, as well as any time you load the system defaults.

Password Protection

All instrument and measurement configuration routines are password protected. A dialog box will open and request a password each time you access these routines. This dialog will time out if you do not enter data within 15 seconds. After 15 seconds, you must restart the configuration routine in order to reactivate the password dialog box.

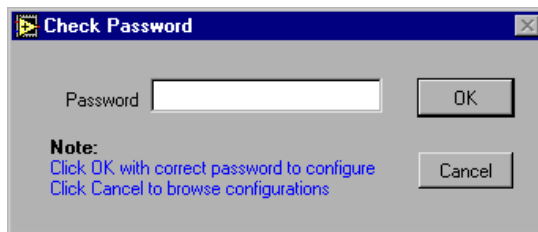


Figure 2-1. Password Dialog Box

Sound Power Plus ships without an initial password (no characters in the password field). To set a new password or change the password, select **Option»New Password**. To disable the password protection feature, use a blank field as the password.

Enter the password you have selected and click **OK**. After you enter the valid password, you can view, edit, and save instrument and measurement configuration options.

If you do have the correct password, you will only have read-only access to configuration options and settings.



Note If you lose or forget your password, contact National Instruments technical support for assistance.

Configuring Your Instruments

The following sections describe how to configure your instruments. The first step is to load the configuration information into Sound Power Plus, either manually or from an existing file

To load instrument configuration data from a file, select **Configuration»Load»Instrument Configuration**. A dialog box prompts you to enter the name of the file you want to load. The instrument configuration file must be compatible with the number of boards and devices currently installed on the system and in Sound Power Plus native file format. Select **Configuration»Load»Default»Instrument Configuration** if you want to load the default instrument configuration files.

To manually enter new configuration data or modify existing data, launch the instrument configuration routine by selecting **Configuration»Settings»Instrument**, and then selecting a device to configure. The Instrument Configuration flowchart window opens, from which you can configure other devices. You can edit the following settings:

- **Board**—Controls and indicators related to the number of DAQ boards and configured measurement channels for the system



Note Sound Power Plus automatically detects all boards installed on your computer when you execute the **Configuration»Settings»Instrument»Board** routine. Each detected board is automatically enabled and all available input channels are activated.

- Multiplexer—Controls and indicators that let you select and configure multiplexers on each configured instrument channel
- Microphone—Controls and indicators that let you assign microphones to each configured input channel using either a DAQ direct input or a multiplexer. Access to Excel microphone data files that include calibration and frequency response data for system microphones is available through this option.

This routine is password protected. If you do not enter the correct password, you cannot modify the current instrument configuration settings.

For a more detailed explanation of configuration concepts, refer to Appendix A, *Configuration Concepts, Protocols, and Calculations*.

Data Acquisition (DAQ) Board Configuration

Figure 2-2 illustrates the Data Acquisition Board Configuration window.

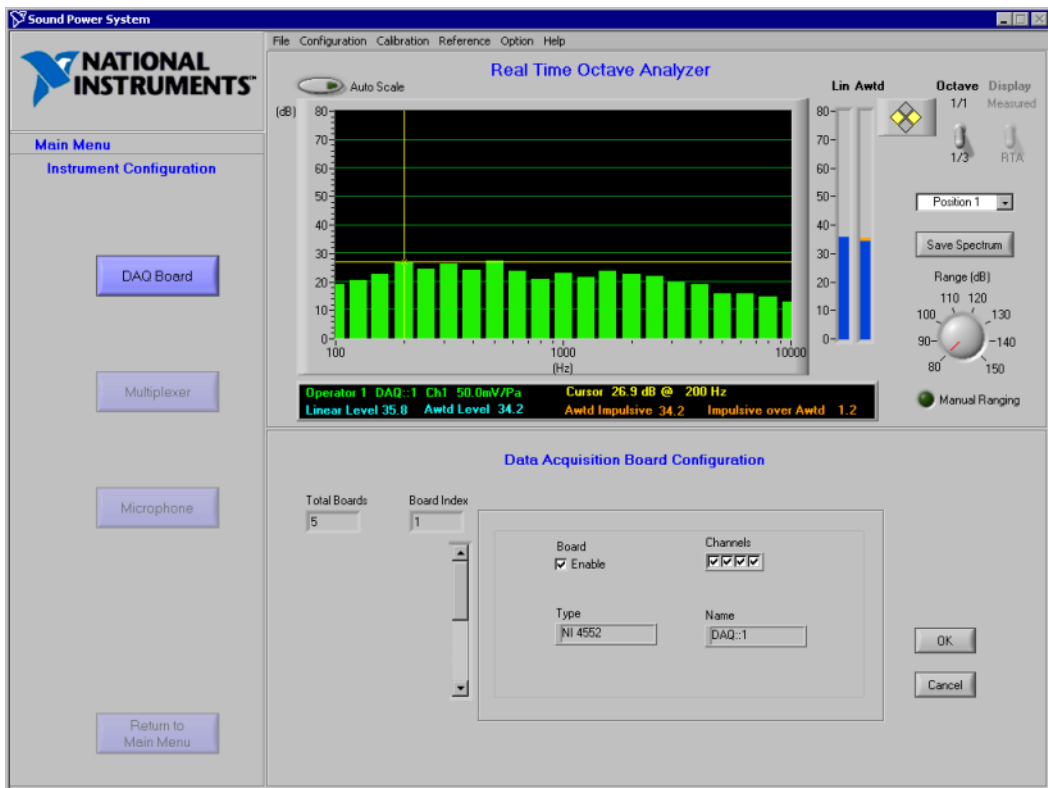


Figure 2-2. Data Acquisition Board Configuration Window

Use this interface to set up your NI 4551 or NI 4552 DSA device. You can access this window by selecting **Configuration»Settings»Instrument»Board** from the main menu bar, which activates the Instrument Configuration flowchart window. From the flowchart window, you can choose other instrument configuration options.

Board—Select this check box to enable the DAQ device. This check box must be selected for at least one board or you will be unable to perform any measurements or configuration.

Type—Sound Power Plus automatically detects and identifies the type of DAQ board installed in your system.

Channels—Select a check box to enable the input channel(s) on the DAQ board.

Name—The name assigned by the software that the system uses to refer to this DAQ board.

OK—Click this button to accept the values you entered and exit the DAQ board configuration.

Cancel—Click this button to cancel your entries and exit the DAQ board configuration.

Multiplexer Configuration

Figure 2-3 illustrates the Multiplexer Configuration window.

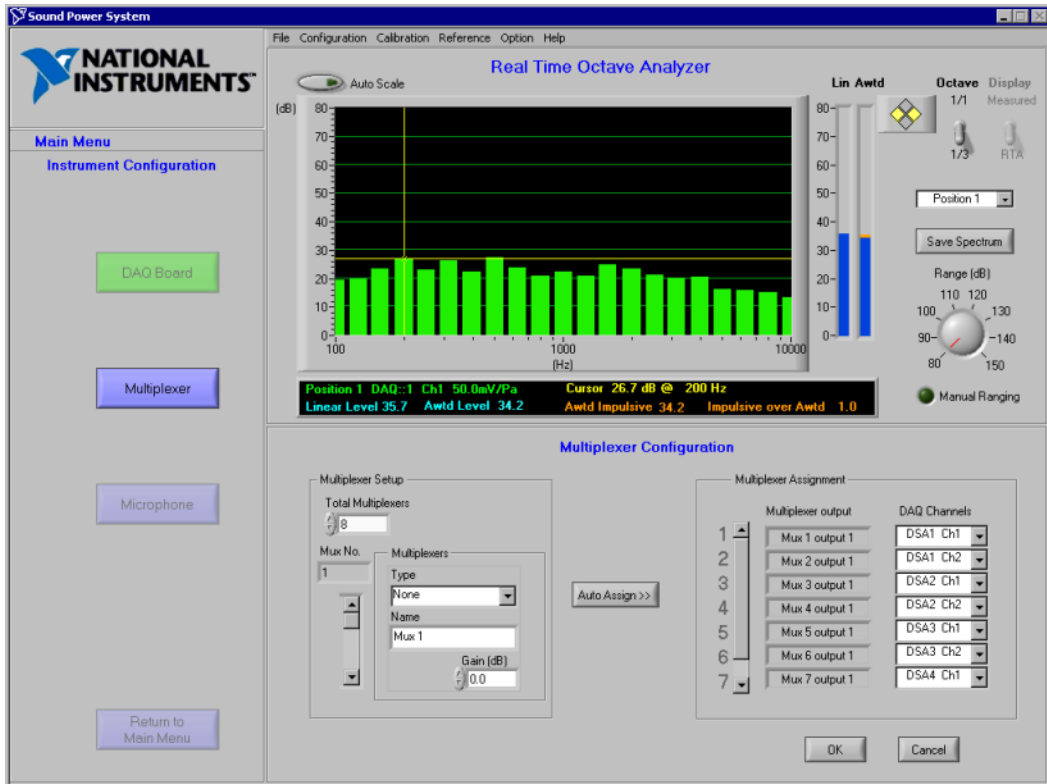


Figure 2-3. Multiplexer Configuration Window

Use this window to set up your multiplexers. You can access this window by selecting **Configuration»Settings»Instrument»Multiplexer** from the main menu bar or by clicking **Multiplexer** when the Instrument Configuration flowchart window is active.

Each DAQ input channel is capable of supporting a multiplexer. Sound Power Plus provides several common microphone multiplexers and supports plug-in driver architecture for new multiplexers so that you can add new National Instruments or custom multiplexer drivers according to the plug-in driver structure. Refer to Appendix C, *Supported Drivers*, for more information about supported multiplexer drivers and how to add a new plug-in multiplexer driver.



Note You can configure more than one multiplexer in this window. Enter the information for the first multiplexer and then move the scroll bar to toggle through the configuration for each additional multiplexer. Do not click **OK** until you have finished configuring all multiplexers.

Multiplexer Setup

Total Multiplexers—Enter the number of multiplexers you want to use.



Note If you are connecting the microphones directly to the BNC 2140 inputs instead of using a multiplexer, set **Total Multiplexers** to equal to the number of microphones and select **Direct** for the Multiplexer Type.

Mux No.—Move the scroll bar to toggle through the configuration for each of the multiplexers.

Multiplexer Type—Select your multiplexer from this drop-down list box. The configuration information for all multiplexers supported by Sound Power Plus is contained in the configuration file, `\Data\Multiplexer Drivers\Multiplexer.ini`. Refer to Appendix C, *Supported Drivers*, for more information on using default and plug-in drivers in Sound Power Plus.

Multiplexer Name—Enter a name to identify each multiplexer. This name is displayed during measurements. You can change this name by entering the new name in the same text box.

GPIO Address/Serial Port—This field varies based on whether your multiplexer is GPIO or serial. Enter the GPIO or serial address of the multiplexer in this field.

Gain (dB)—Each multiplexer channel may have an associated pre-gain. If you are using a pre-gain amplifier on the output of the multiplexer to increase the signal-to-noise ratio of the system, enter the gain applied, in decibels. This gain is taken into account when calibrating microphones, that is, it is included in the microphone sensitivity.

Auto Assign—Click this button to direct Sound Power Plus to automatically assign each multiplexer output to the available measurement channels in a logical order.



Note Always review the automatic configuration assignments to ensure that the logic applied is consistent with your current instrument or measurement configuration requirements.

Multiplexer Assignment

You can assign the output of each configured multiplexer to an input channel on your DAQ board.

Multiplexer Output—This indicator lists each multiplexer output you configured in Multiplexer Setup.

DAQ Channels—Use this list box to select an input channel on the DAQ board to associate with the multiplexer output.

OK—Click this button to accept the values you entered and exit the multiplexer configuration.

Cancel—Click this button to cancel your entries and exit the multiplexer configuration.

Microphone Configuration

Figure 2-4 illustrates the Microphone Configuration window.

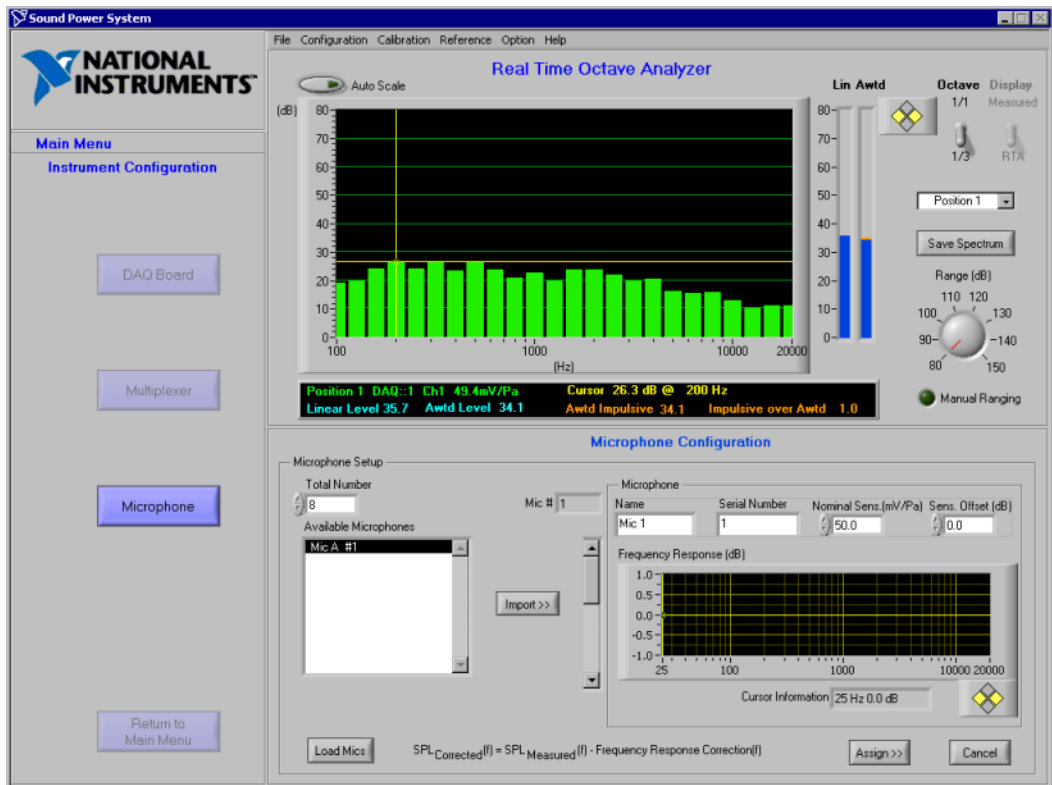


Figure 2-4. Microphone Configuration Window

Use this window to establish a relationship between your microphones and measurement channels. You can access this window in the following ways selecting **Configuration»Settings»Instrument»Microphone** from the main menu bar or clicking **Microphone** when the Instrument Configuration flowchart window is active.

Based on the number of microphones specified in the **Total Number** control, Sound Power Plus assigns a serially-numbered group of microphones, beginning with microphone one (Mic 1). For a description of how microphones are assigned, refer to the [Measurement Configuration](#) section in Appendix A, [Configuration Concepts, Protocols, and Calculations](#).

You can reassign any microphone to any configured board, input channel, and multiplexer channel. However, each microphone must be assigned to a unique multiplexer channel or DAQ input channel.

Total Number—Enter the total number of microphones you want to configure.

Load Mics—Click this button to import the microphone data from an Excel microphone sensitivity file. When you click this button, a file dialog box opens from which you can choose the microphone sensitivity file you want to load. Select a file and click **Open**. The Excel file stores microphone names, serial numbers, sensitivity offsets, and frequency response corrections. See the *Microphone Sensitivity Files* section in Appendix B, *Program and Data Files*, for more information about viewing and editing the microphone sensitivity files.

Available Microphones—This list box contains the configured microphones that are available. This information is available once you click **Load Mics**.

Mic #—Move the scroll bar to toggle through the configuration settings for each of the microphones by microphone number.

Import—Click this button to assign the microphone you selected from the **Available Microphones** field to the microphone number indicated in the **Mic #** field.

Microphone

You can configure microphones by importing data from the **Available Microphones** list or by entering the values by hand into the Microphone Configuration data window. Frequency response corrections can only be imported from the data contained in the Excel microphone sensitivity files.

Name—A common name Sound Power Plus uses to refer to the microphone (such as Microphone 1, Mic A, and so on). You can select a name from the **Available Microphones** list box, assign a name by editing the field, or accept the default name assigned by Sound Power Plus.

Serial Number—Enter a serial number that uniquely identifies the microphone by editing this field or importing the serial number from the **Available Microphones** list.

Nominal Sensitivity (mV/Pa)—Enter the nominal sensitivity (as assigned by the manufacturer) of the microphone in mV/Pa. The default value of this control is 50 mV/Pa. Enter the nominal sensitivity by editing this field or importing the value from the **Available Microphones** list.

Sensitivity Offset (dB)—Enter the amount (in dB) that the normal sensitivity of the microphone differs from its nominal sensitivity. The default microphone sensitivity file is set to an initial value of 0.0 dB.

Frequency Response—This graph shows the frequency response correction (in dB) that will be applied for each 1/3-octave band for the selected microphone. Frequency response corrections can only be modified in the Excel microphone sensitivity files, which you can load into Sound Power Plus by clicking **Load Mics**.

Cursor Information—This indicator returns the frequency response correction for the selected 1/3-octave band.

Assign—Click this button to launch a Microphone Configuration screen. This screen is described in the next section.

Cancel—Click this button to cancel your entries and exit the microphone configuration.

Microphone Assignment

Figure 2-5 illustrates the Microphone Assignment window.

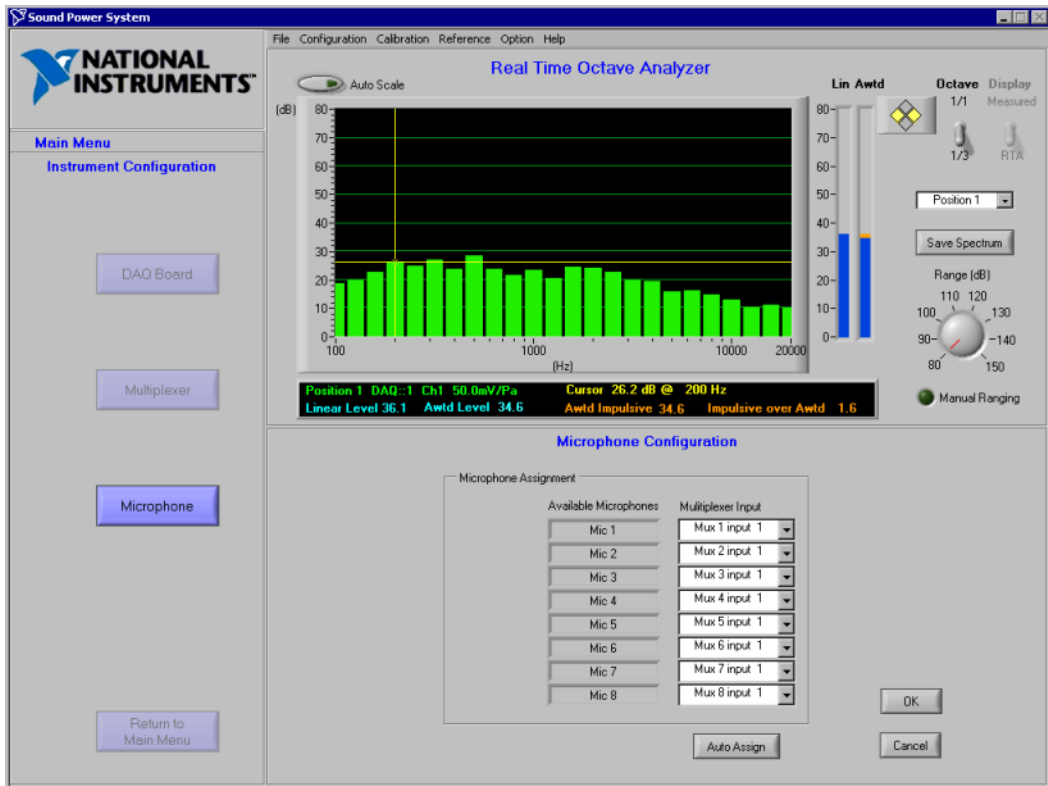


Figure 2-5. Microphone Assignment Window

Use this window to assign your microphone to a multiplexer input channel (or DAQ input channel if no multiplexer is used). Access this window by selecting **Configuration»Settings»Instrument»Microphone** from the main menu bar and clicking the **Assign** button or by clicking **Microphone** and then **Assign** when the Instrument Configuration flowchart window is active.

Available Microphones—This field lists the microphones available on the system as configured on the previous screen. Move the slider to toggle through the configuration for each of the microphones.

Multiplexer Input—Select a channel from this list box to assign a multiplexer input channel to an available microphone.

Auto Assign—Click this button to sequentially assign the microphones to input channels.



Note Always review the automatic configuration assignments to ensure that the settings are consistent with your current instrument or measurement configuration requirements.

OK—Click this button to accept the values and return to the main Instrument Configuration window.

Cancel—Click this button to ignore your changes and return to the main Instrument Configuration flowchart.

Select **Configuration»Save»Instrument Configuration** to save the current instrument configuration settings. A dialog box prompts you to enter the name of the file, and then the file is saved in Sound Power Plus native file format. Select **Configuration»Save»Default»Instrument Configuration** to save the current instrument configuration to the system instrument configuration default file `Global_Instrument Configuration_Default.Inc`.

Configure A Sound Power Level Measurement

The following sections describe how to configure your sound power level (PWL) measurement.

Load A Measurement Configuration File

You can either load configuration information into Sound Power Plus from a file, or enter new configuration data. To load sound power level measurement configuration data from a file, select **Configuration»Load»PWL Measurement Configuration**. A dialog box prompts you to enter the name of the file you want to load. The data in the file must be compatible with the current instrument configuration and the file must be saved in Sound Power Plus native file format. Select **Configuration»Load»Default»PWL Measurement Configuration** to load the default sound power level measurement configuration files.



Note Sound Power Plus displays the current instrument, sound power level, and sound pressure level configuration files in the data window when the main program menu is active in the flowchart window.

Enter New Measurement Configuration Data

To enter or change configuration data, launch the sound power level measurement configuration routine by selecting **Configuration»Settings»Sound Power Level Measurement** and choosing the setting you want to configure. The PWL Measurement Configuration flowchart window opens. Use this window to configure other sound power level measurement settings, such as:

Measurement—Configure the basic measurement parameters for a sound power level measurement.

Position—Configure measurement positions, assign microphones to each position, and configure the measurement sequence for each position.

Ambient Correction—Configure the method to use while conducting ambient noise corrections.

Environmental Correction—Input a series of corrections for the effect of the acoustic environment on the sound pressure level measurement for sound power, known as K2 values.

Measurement Option—Configure several measurement options associated with the sound power level routine.

FFT Measurement—Configure the measurement options for the source sound power level FFT routine and the measurement sequence of selected positions.

This routine is password protected. If you do have the correct password, you will only have read-only access to configuration options and settings.

For a more detailed explanation of configuration concepts, refer to Appendix A, *Configuration Concepts, Protocols, and Calculations*.

Measurement Configuration

Figure 2-6 illustrates the Sound Power Level Measurement Configuration data window.

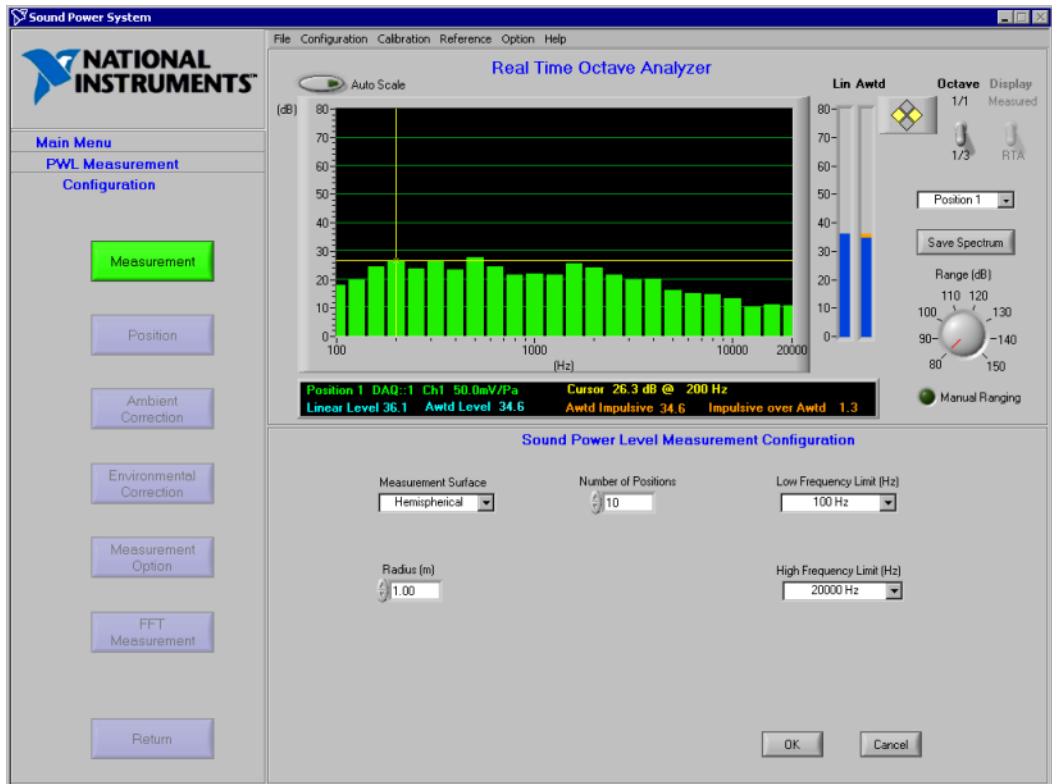


Figure 2-6. Sound Power Level Measurement Configuration Data Window

Use this window to set up a sound power level measurement. You can access this window by selecting **Configuration»Settings»Sound Power Level Measurement»Measurement** from the main menu bar. This selection activates the PWL Measurement Configuration flowchart window, from which you can choose other measurement configuration options.

Before you begin a sound power level measurement, you must select a measurement surfaces from the **Measurement Surface** list box. For hemi-anechoic chambers, choose a hemispherical, parallelepiped (box), or cylindrical measurement surface. Select a spherical measurement surface for full-anechoic chambers.



Note All parallelepiped measurement surfaces are assumed to be in hemi-anechoic environments.

Radius (m)—Choose a Hemispherical or Spherical surface to enable the this control. You can specify a radius from 0.50 to 4.00 meters.

Length, Width, Height—Choose a Parallelepiped surface to enable these controls (not shown in figure). The dimension fields follow the dimensioning conventions defined by ISO 7779.

Radius (m), Height (m)—Choose a Cylindrical surface to enable these controls.

Number of Positions—Use this text box to specify the number of measurement positions you want to use in your sound power measurement. You can assign each microphone to more than one position, so the number of measurement positions is not dependent on the number of microphones available for measurement.

Low Frequency Limit (Hz)—Use this list box to select the lowest measurement frequency for your sound power level measurement. The default measurement setup file has an initial value of 100 Hz. This control also sets the low limit of the range viewable in the RTA window.

High Frequency Limit (Hz)—Use this list box to select the highest measurement frequency for your sound power measurement. The default measurement setup file has an initial value of 20,000 Hz. This also sets the high limit of the range viewable in the RTA window.



Note Sound Power Plus supports measurements that fall within a frequency range of 25 to 20,000 Hz. The **Low Frequency Limit** must be less than the **High Frequency Limit**.

OK—Click this button to accept values you entered and exit the measurement configuration.

Cancel—Click this button to cancel your entries and exit the measurement configuration.

Position Configuration

Figure 2-7 illustrates the Sound Power Level Measurement Position Configuration data window.

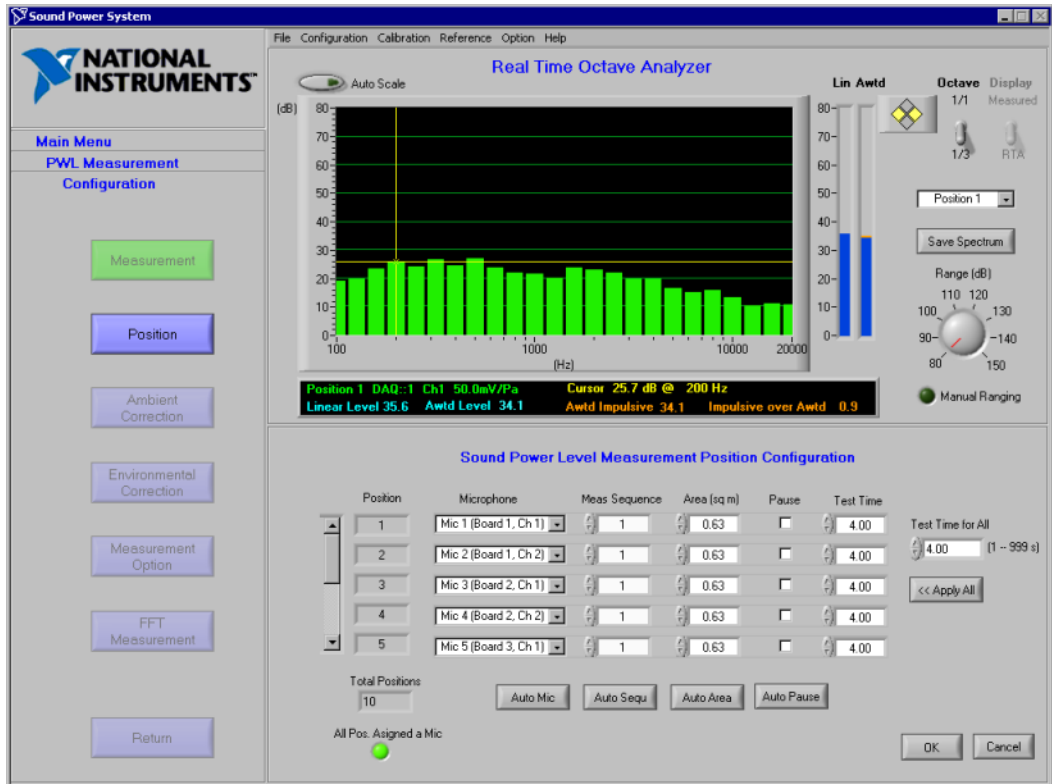


Figure 2-7. Sound Power Level Measurement Position Configuration Data Window

Use this window to assign a microphone configured during instrument configuration to each measurement position. Access this window by selecting **Configuration»Settings»Sound Power Level Measurement»Position** from the main menu bar or by clicking **Position** when the PWL Measurement Configuration flowchart window is active.

Position—This indicator displays a position number for each measurement position, as you specified in the Measurement Configuration. Use the slider bar to scroll through the available positions.

Total Positions—This indicator displays the total number of positions you set in the Measurement Configuration window.

Microphone—Use this list box to select a configured microphone to assign to the measurement position. The list box lists all microphone names and data acquisition channels connected to the microphones, as specified in your system configuration. Click **Auto Mic** to assign microphones sequentially to each position.

Auto Mic—Click this button if you want to automatically assign a microphone to each position. Microphones are assigned according to the number of microphones configured on the system in the Microphone Configuration in relation to the number of positions configured in the Measurement Configuration. Microphones are assigned in sequential order to each position until all microphones have been assigned, and then the sequence repeats until all positions have been assigned.

Meas Sequence—Use this list box to enter a sequence number for sound pressure measurement. During ambient or source sound pressure level measurement, Sound Power Plus measures positions according to this sequence number. Positions with the same sequence number are measured at the same time.

Auto Seq—Click this button if you want to automatically assign a measurement sequence number to each position in the most logical order (measuring as much position at one sequence as possible).



Note Always review the automatic configuration assignments generated by the auto assignments (**Auto Mic**, **Auto Seq**, **Auto Area**, and **Auto Pause**) to ensure that the settings are consistent with your current instrument or measurement configuration requirements.

The NI 4551 device features two input channels. The device can measure 1/3-octave band sound pressure levels ranging from 25 to 20,000 Hz on both channels simultaneously.

The NI 4552 device features four input channels, and can measure 1/3-octave band sound pressure levels ranging from 25 to 10,000 Hz on these four channels simultaneously. The device can also measure 1/3-octave band sound pressure levels from 25 to 20,000 Hz on any two channels simultaneously.



Note The NI 4552 cannot measure 1/3-octave band sound pressure levels from 25 to 20,000 Hz on all four of its channels simultaneously.

Area (sq m)—Use this list box to enter a value (in square meters) for the surface area associated with each measurement position. This value is used to weigh the surface average sound pressure level (as described in ISO 3745, section 7.7.1.2).

Auto Area—Click this button to automatically divide the total measurement surface area evenly among all measurement position. If each measurement position in the sound power measurement is a representative of the same area, use this control to complete the **Area** field for each position.



Note When you click **OK**, the software checks the area value and measurement sequence. An error occurs if the sum of the areas you entered differs from the total calculated surface area of the measurement, as defined by the size and shape configured in the Sound Power Level Measurement Configuration interface, by a value greater than 0.1 dB. You must reconcile the individual area fields with the total measurement surface area before the position configuration is accepted. If positions that are assigned to the same measurement sequence cannot be measured at the same time (for example, if two positions use the same channel or exceed the board's measurement capability), an error appears. You must check the measurement sequence setup and correct the sequencing to correct this error.

Pause—Select this check box to stop the measurement sequence after a measurement position. The measurement sequence pauses if at least one position in a single measurement sequence is set to **Pause**. Use **Pause** if you need to move a microphone to a new position between measurements.

Auto Pause—Click this button to automatically assign pauses after each position based on a logical comparison between the number of measurement positions and the number of microphones available. For example, on a measurement with ten positions using two microphones, Sound Power Plus would automatically assign a pause to positions two, four, six, and eight.

Test Time—Enter the length of time (in seconds) that you want Sound Power Plus to measure each position. Valid values range from 1 to 999 seconds.



Note You can override the current **Pause** and **Test Time** selections during the ambient and source sound pressure level measurement routines. However, you can only save these settings to a measurement setup file from this routine.

Test Time for All—Enter the length of time (in seconds) in this field to set the test time for all measurements to the same value.

Apply All—Click this button to apply the **Test Time for All** value to the **Test Time** field for each position.

All Pos. Assigned a Mic—If this indicator is green, all configured measurement positions are assigned to a valid microphone. This indicator must be green for you to save the position configuration without an error.

OK—Click this button to accept the values you entered and exit the position configuration.

Cancel—Click this button to cancel your entries and exit the position configuration.

Ambient Correction Configuration

Figure 2-8 illustrates the Sound Power Level Measurement Ambient Correction Configuration data window.

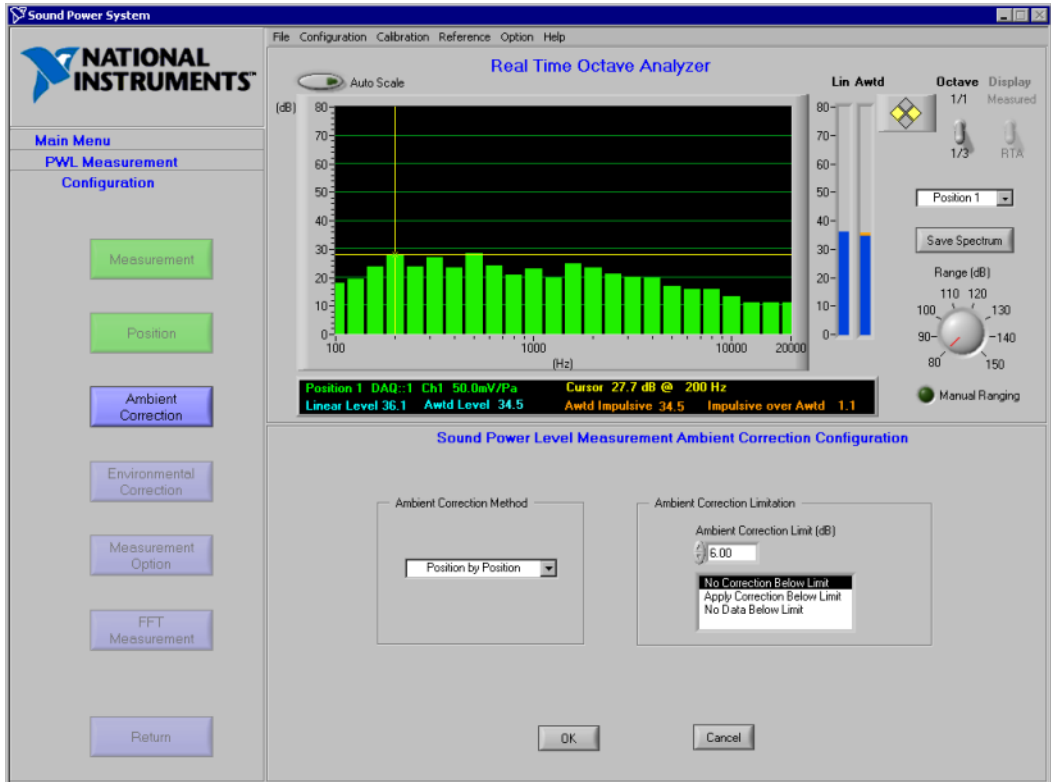


Figure 2-8. Sound Power Level Measurement Ambient Correction Configuration Data Window

Use this window to configure how ambient noise corrections are applied to the data. This allows the software to address several different test standards, all of which deal with ambient noise corrections in a different manner. You can access this window by selecting **Configuration»Settings»Sound Power Level Measurement»Ambient Correction** from the main menu bar or by clicking **Ambient Correction** when the PWL Measurement Configuration flowchart window is active.

Ambient Correction Method—Select a method for making ambient noise corrections. These methods are described in detail in Appendix A, *Configuration Concepts, Protocols, and Calculations*.

- **Position-by-Position**—The source sound pressure level at each position is corrected using the ambient sound pressure level recorded at that position, prior to surface averaging. This option is enabled in the default measurement configuration file.
- **Surface Average**—Use the surface average ambient sound pressure level is then used to correct the surface averaged source sound pressure level.

Ambient Correction Limitation

Use this control to configure how ambient noise corrections are conducted when the source sound pressure level does not exceed the ambient sound pressure level by a limit value.

Ambient Correction Limit (dB)—Enter a value in this field for the difference between the source and ambient sound pressure levels, below which either no ambient corrections or fixed corrections are applied. The initial value assigned in the default measurement configuration file is 6.0 dB.

- **Correct Below Limit**—Select an ambient correction method to apply if the difference between ambient and source sound pressure levels exceeds the limit you set.
- **No Correction Below Limit**—No correction is applied if the difference between source and ambient sound pressure levels is less than the ambient correction limit (see ISO 7779-1988, section 6.7.3).
- **Apply Correction Below Limit**—A fixed correction (equal to the correction that would be applied at the ambient correction limit) is applied to the source sound pressure level data if the difference between source and ambient sound pressure levels is less than the ambient correction limit (see ISO 3744-1994, section 8.3).
- **No Data if Below Limit**—No data is reported in bands that are within the ambient correction limit of the ambient sound pressure level (see ISO 3745-1977, section 7.6).

OK—Click this button to accept the values you entered and exit the ambient correction configuration.

Cancel—Click this button to cancel your entries and exit the ambient correction configuration.

Environmental Correction Configuration

Figure 2-9 illustrates the Sound Power Level Measurement Environmental Correction data window.

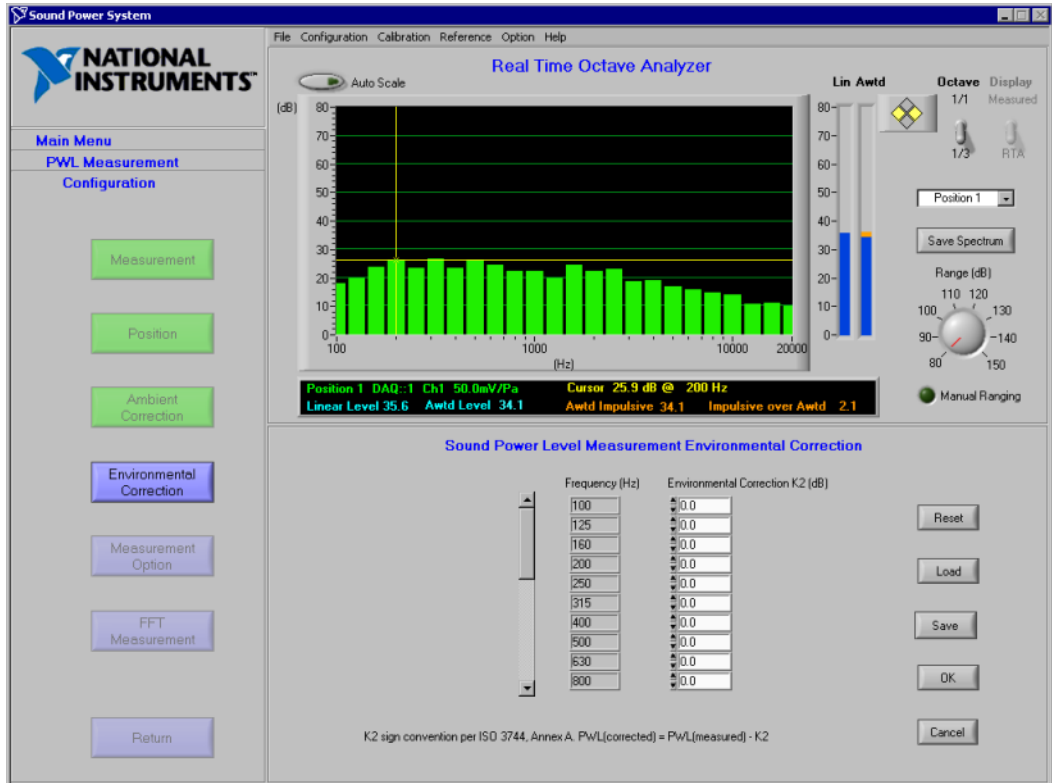


Figure 2-9. Sound Power Level Measurement Environmental Correction Data Window

Input the environmental corrections factor to apply to your sound power measurement into this interface. This environmental factor is referred to as K2 in standards such as ISO 7779 (1988, section 6.8) and ISO 3744 (1994, section 8.4). You can access this window by selecting **Configuration»Settings»Sound Power Level Measurement»Environmental Correction** from the main menu bar or by clicking **Environmental Correction** when the PWL Measurement Configuration flowchart window is active.



Note Entries in this window are optional. The initial values assigned in the default measurement configuration file are 0.0 dB.

Frequency (Hz)—A frequency is automatically provided for each 1/3-octave band center frequency in the frequency range you set during Measurement Configuration. Use the slider bar to scroll through available frequencies.

Environmental Correction K2 (dB)—Enter a value (in dB) to be applied to the surface average sound pressure level in each 1/3-octave band to correct for the influence of the acoustic test environment.

Reset—Click this button to revert to the previously saved K2 values.

Load—Click this button to load K2 values from a measurement configuration file.

Save—Click this button to save the current K2 values to a measurement configuration file.



Note When you use the on-screen buttons, you are limited to the Save and Load functions. Use the menu bar to load a sound power level measurement configuration file if you want to load all six measurement configuration screens.

OK—Click this button to accept the K2 values you entered and exit the environmental corrections configuration.

Cancel—Click this button to cancel your entries and exit the environmental corrections configuration.

Measurement Option Configuration

Figure 2-10 shows the Sound Power Level Measurement Option Configuration data window.

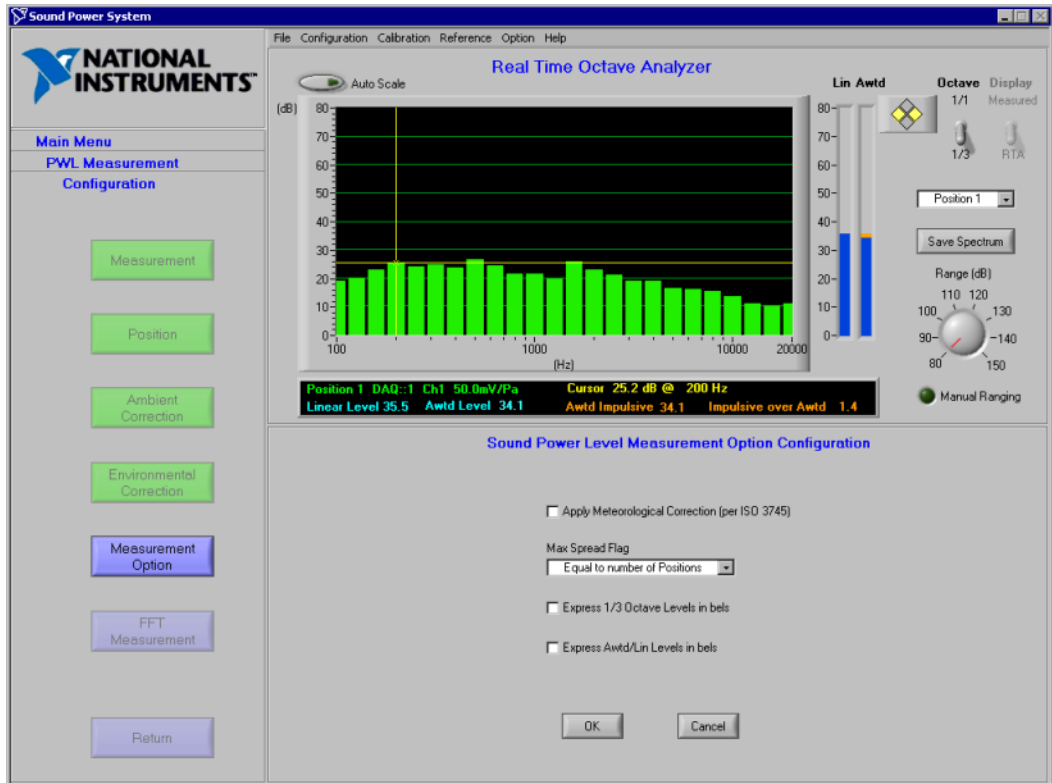


Figure 2-10. Sound Power Level Measurement Option Configuration Data Window

Use this window to configure the measurement options for the sound power measurement routine. You can access this window by selecting **Configuration»Settings»Sound Power Level Measurement»Measurement Option** from the main menu bar or by clicking **Measurement Option** when the PWL Measurement Configuration flowchart window is active.

Apply Meteorological Correction (per ISO 3745)—Select this check box to enable the correction term based on temperature and barometric pressure, as defined in ISO 3745-1977, section 8.1. The data in **Test Documentation»Meteorological Information** is used to calculate this

correction. (For more information, see the *Meteorological Information* section in Chapter 3, *Documenting Your Test*.) In the default measurement configuration file, this option is not selected.

Max Spread Flag—Use this list box to configure the software to specify a maximum limit to the difference between the maximum and minimum sound pressure levels as a function of the number of measurement positions, as required in ISO 7779-1988, section 6.6.3; ISO 3744-1994, section 7.2.2 and 7.3.2; and ISO 3745-1977, section 7.3.2.2. When you set this, an Additional Position Flag alert appears when the max spread is exceeded. The following options are supported:

- Equal to the Number of Measurement Positions—The Additional Positions Flag is set if the difference between the maximum and minimum sound pressure levels exceeds the number of measurement positions. The default sound power level measurement configuration file uses this option.
- Equal to Half the Number of Measurement Positions—The Additional Positions Flag is set if the difference between the maximum and minimum sound pressure levels exceeds half the number of measurement positions.

Express 1/3 Octave Sound Power Levels in bels—Select this option to calculate all 1/3-octave band sound power level results in bels (1 bel = 10 dB).

Express Awtd/Lin Levels in bels—Select this option to calculate the Awtd and linear sound power level results in bels (1 bel = 10 dB).



Note ISO 7779, ISO 3744, and ISO 3745 call for the expression of sound power levels in decibels (re 1 pW). However, some product declaration standards, such as ISO 9296, call for declaration of Awtd sound power levels in bels. Selecting one of the **Express** options allows you to work with sound power levels in bels in order to be consistent with product declaration standards.

OK—Click this button to accept the values you entered and exit the measurement options configuration.

Cancel—Click this button to cancel your entries and exit the measurement options configuration.

FFT Measurement Configuration

Figure 2-11 illustrates the Source FFT Measurement Configuration data window.

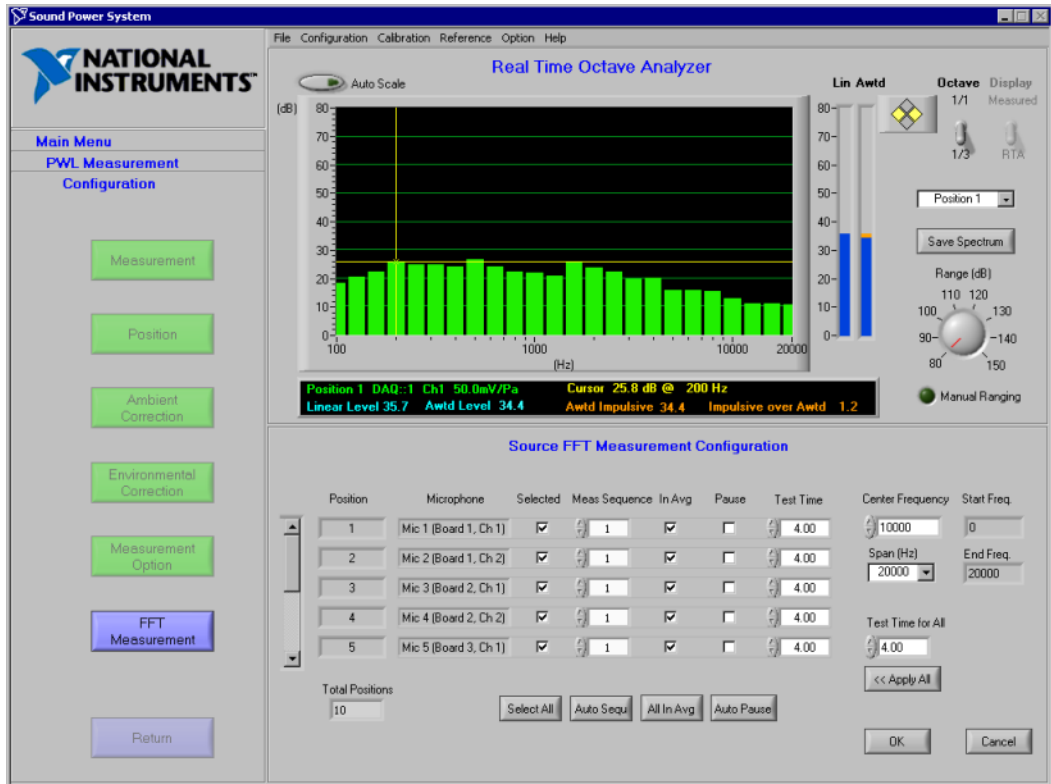


Figure 2-11. Source FFT Measurement Configuration Data Window

Use this window to configure parameters for measuring sound pressure levels at any configured microphone position using an FFT analyzer. You can access this window by selecting **Configuration»Settings»Sound Power Level Measurement»FFT Measurement** from the main menu bar or by clicking **FFT Measurement** when the PWL Measurement Configuration flowchart window is active.



Note Entries in this window are optional.

Position—An indicator that displays a position number for each measurement position you specified in the Measurement Configuration. Use the slider bar to scroll through the available positions.

Total Positions—An indicator that displays the total number of positions you set during the Measurement Configuration.

Mic—An indicator that displays the microphone name that you assigned to this position during the Position Configuration and the data acquisition channel connected to each microphone after the name of each microphone.

Selected—Select a check box to designate the position or positions that you want to measure.

Select All—Click this button to select all measurement positions.

Meas Sequence—Use this list box to enter a sequence number for FFT measurement. During FFT measurement, Sound Power Plus measures positions according to this sequence. Positions with the same sequence are measured at the same time.

Auto Seq—Click this button to automatically assign a measurement sequence number to each position in the most logical order (measuring as many positions in one sequence as possible).



Note The NI 4551 and NI 4552 devices can only take simultaneous FFT measurements on two channels per board at a given time, regardless of the measurement frequency range.

Included in Avg—Select a check box to designate the position(s) you want to include in the average FFT spectrum generated by the source sound pressure level FFT routine.

Include All—Click this button to select all positions for inclusion in the average FFT spectrum.

Paused—Select this check box to stop the measurement sequence after a measurement position. The measurement sequence pauses if at least one position in a single measurement sequence is set to **Pause**. Use **Pause** if you need to move a microphone to a new position between measurements.

Auto Pause—Click this button to automatically assign pauses after each position based on a logical comparison between the number of measurement positions and the number of microphones available.

Test Time—Enter the length of time (in seconds) that you want Sound Power Plus to measure each position. Valid values range from 1 to 999 seconds.

Test Time for All—If you want to set the test time for all measurement positions to the same value, enter the length of time (in seconds) in this field.

Apply All—Click **Apply All** to enter the **Test Time for All** value into the **Test Time** field for each position.

Center Frequency—Enter the center frequency of the bandwidth to be analyzed by the FFT measurement. The center frequency and span controls are used together to set up base band or zoom-FFT measurements. For example, to set up a base band FFT of 20 kHz, set the center frequency to 10,000 Hz and the span to 20,000 Hz.

Span (Hz)—Select the span of the FFT measurement, which will be centered on the center frequency.

Start Freq.—This indicator displays the low frequency limit of the FFT measurement. The low frequency limit is determined by the center frequency minus one half of the span.

End Freq.—This indicator displays the high frequency limit of the FFT measurement. The high frequency limit is determined by the center frequency plus one half of the span.

OK—Click this button to accept the values you entered and exit the source FFT measurement configuration.

Cancel—Click this button to cancel your entries and exit the source FFT measurement configuration.

Select **Configuration»Save»PWL Measurement Configuration** to save the current sound power level measurement configuration settings. A dialog box prompts you to enter the name of the file, and the file is then saved in Sound Power Plus native file format.

Select **Configuration»Save»Default»PWL Measurement Configuration** to save the current sound power level measurement configuration to the default sound power level measurement configuration file named `Global_Sound Power Level_Default.PWC`.

Configure A Operator/Bystander Sound Pressure Level Measurement

The following sections describe how to configure your operator or bystander sound pressure level (SPL) measurement.

Load A Configuration File

You can either load SPL configuration information into Sound Power Plus from a file, or enter new configuration data. To load SPL measurement configuration data from a file, select **Configuration»Load»SPL Measurement Configuration**. A dialog box prompts you to enter the name of the file you want to load. The data in the file must be compatible with the current configuration and in Sound Power Plus native file format. Select **Configuration»Load»Default»SPL Measurement Configuration** if you want to load the default operator/bystander SPL measurement configuration files.



Note The current instrument, sound power level, and sound pressure level configuration files are displayed in the data window when the main program menu is active in the flowchart window.

Enter New Configuration Data

To enter new or change configuration data, launch the sound pressure level measurement configuration routine by selecting **Configuration»Settings»Sound Pressure Level Measurement**, then select a setting to configure. This launches the Sound Pressure Level Measurement Configuration flowchart window, from which you can configure other sound pressure level measurement settings. You can edit the following SPL measurement settings:

- **Measurement**—Controls and indicators that let you configure the basic measurement parameters for an operator/bystander sound pressure level measurement.
- **Position**—Controls and indicators that let you select operator and bystander measurement positions and assign microphones and measurement sequence numbers to each position.
- **Ambient Correction**—Controls and indicators that let you configure the method to use while conducting ambient noise corrections.
- **Sound Quality**—Controls and indicators that let you configure the options for the sound quality (impulsive and prominent tone) analysis routine.

This routine is password protected. If you do not enter the correct password, you can browse, but not change, the current configuration settings.

For a more detailed explanation of configuration concepts, refer to Appendix A, *Configuration Concepts, Protocols, and Calculations*.

Measurement Configuration

Figure 2-12 illustrates the Sound Pressure Level Measurement Configuration data window.

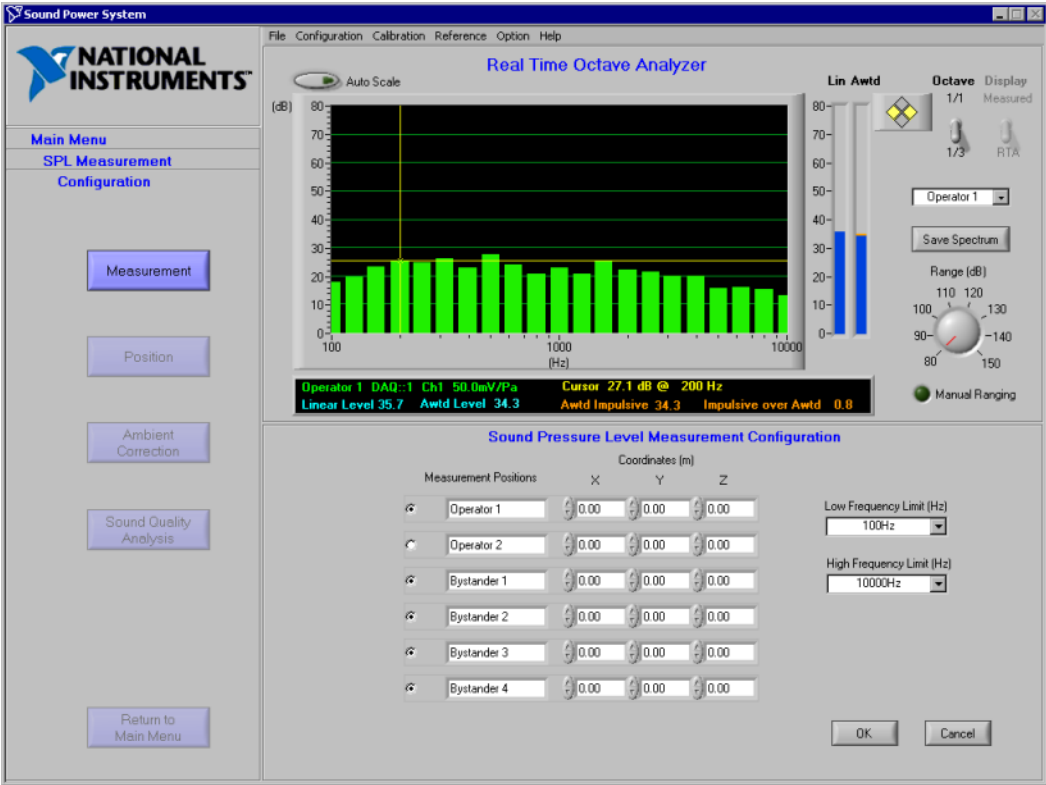


Figure 2-12. Sound Pressure Level Measurement Configuration Data Window

Use this window to set up the operator/bystander sound pressure level measurement. You can access this window by selecting **Configuration»Settings»Sound Pressure Level Measurement»Measurement** from the main menu bar. This activates the SPL Measurement Configuration flowchart window, from which you can choose other configuration options.

The operator position is the position in front of the computer where a user would typically sit. The bystander positions are four positions around a piece of equipment where users might stand if the equipment does not have an operator position (like a server). The operator and bystander positions are defined in the ISO 7779 standard.

Select Position—Use the radio buttons to activate the positions you want to measure.

Measurement Positions—These text boxes are automatically filled in with positions Operator 1, Operator 2, and Bystander 1–4.

Coordinates (m)—Enter coordinates for each measurement position into the **X**, **Y**, and **Z** text boxes, using the unit set in the **Unit** control. The default measurement configuration file is set with initial values of 0.00. These fields are for documentation purposes only and are not used in any calculations.

Unit—Select the dimensions for your measurements. You can choose millimeter, meter, inch, or foot. Sound Power Plus automatically sets **Dimensions** to meter when you save data to a file or generate a report.

Low Frequency Limit (Hz)—Use this list box to select the lowest measurement frequency for the operator/bystander sound pressure level measurement. The default measurement configuration file is set with an initial value of 100 Hz. This also sets the low limit of the range you can view in the RTA window.

High Frequency Limit (Hz)—Use this list box to select the highest measurement frequency for the operator/bystander sound pressure level measurement. The default measurement configuration file is set with an initial value of 20,000 Hz. This also sets the high limit of the range you can view in the RTA window.



Note Sound Power Plus supports frequencies from 25 to 20,000 Hz. The **Low Frequency Limit** must be less than the **High Frequency Limit**.

OK—Click this button to accept the values you entered and exit the measurement configuration.

Cancel—Click this button to cancel your entries and exit the measurement configuration.

Position Configuration

Figure 2-13 illustrates the Sound Pressure Level Measurement Position Configuration data window.

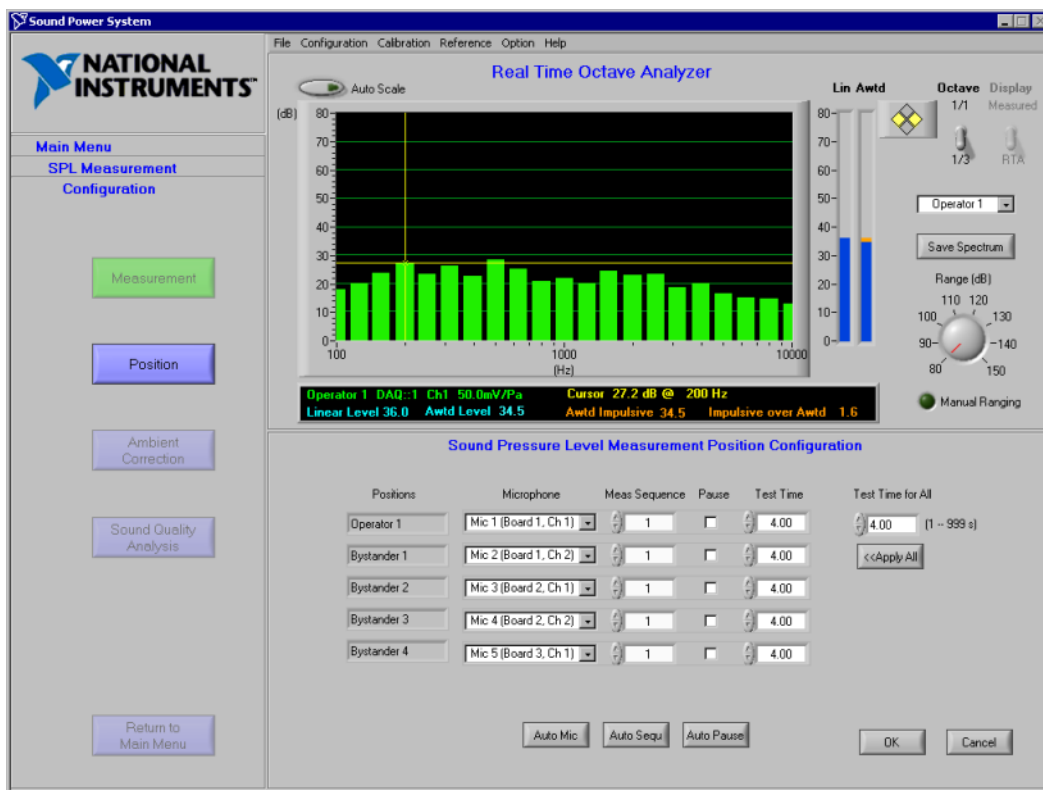


Figure 2-13. Sound Pressure Level Measurement Position Configuration Data Window

Use this window to assign a configured microphone to each measurement position which must be assigned a measurement sequence and to set the measurement parameters. You can access this window in the following ways by selecting **Configuration»Settings»Sound Pressure Level Measurement»Position** from the main menu bar or by clicking **Position** when the SPL Measurement Configuration flowchart window is active.

Position—This box lists each measurement position you selected in the Measurement Configuration.

Microphone—Use this list box to select a configured microphone to assign to the measurement position. The list box lists all microphone names and data acquisition channels connected to the microphones, as specified in your system configuration. Click **Auto Mic** to assign microphones sequentially to each position.

Auto Mic—Click this button if you want to automatically assign a microphone to each position. Microphones are assigned according to the number of microphones configured on the system in the Microphone Configuration in relation to the number of positions configured in the Measurement Configuration. Microphones are assigned in sequential order to each position until all microphones have been assigned, and then the sequence repeats until all positions have been assigned.

Meas Sequence—Use this list box to enter a sequence number for sound pressure measurement. During ambient or source sound pressure level measurement, Sound Power Plus measures positions according to this sequence number. Positions with the same sequence number are measured at the same time.

Auto Seq—Click this button if you want to automatically assign a measurement sequence number to each position in the most logical order (measuring as much position at one sequence as possible).



Note Always review the automatic configuration assignments generated by the auto assignments (**Auto Mic**, **Auto Seq** and **Auto Pause**) to ensure that the logic applied is consistent with your current instrument or measurement configuration requirements.

Pause—Select this check box to stop the measurement sequence after a measurement position. The measurement sequence pauses if at least one position in a single measurement sequence is set to **Pause**. Use **Pause** if you need to move a microphone to a new position between measurements.

Auto Pause—Click this button to automatically assign pauses after each position based on a logical comparison between the number of measurement positions and the number of microphones available. For example, on a measurement with ten positions using two microphones, Sound Power Plus would automatically assign a pause to positions two, four, six, and eight.

Test Time—Enter the length of time (in seconds) that you want Sound Power Plus to measure each position. Valid values range from 1 to 999 seconds.

Test Time for All—Enter the length of time (in seconds) in this field to set the test time for all measurements to the same value.



Note You can override the current **Pause** and **Test Time** selections during the ambient and source sound pressure level measurement routines. However, you can only save these settings to a measurement setup file from this routine.

Apply All—Click the **Apply All** button to enter the **Test Time for All** value in the **Test Time** field for each position.

OK—Click this button to accept the values you entered and exit the position configuration.

Cancel—Click this button to cancel your entries and exit the position configuration.

Ambient Correction Configuration

Figure 2-14 illustrates the Sound Pressure Level Measurement Ambient Correction Configuration data window.

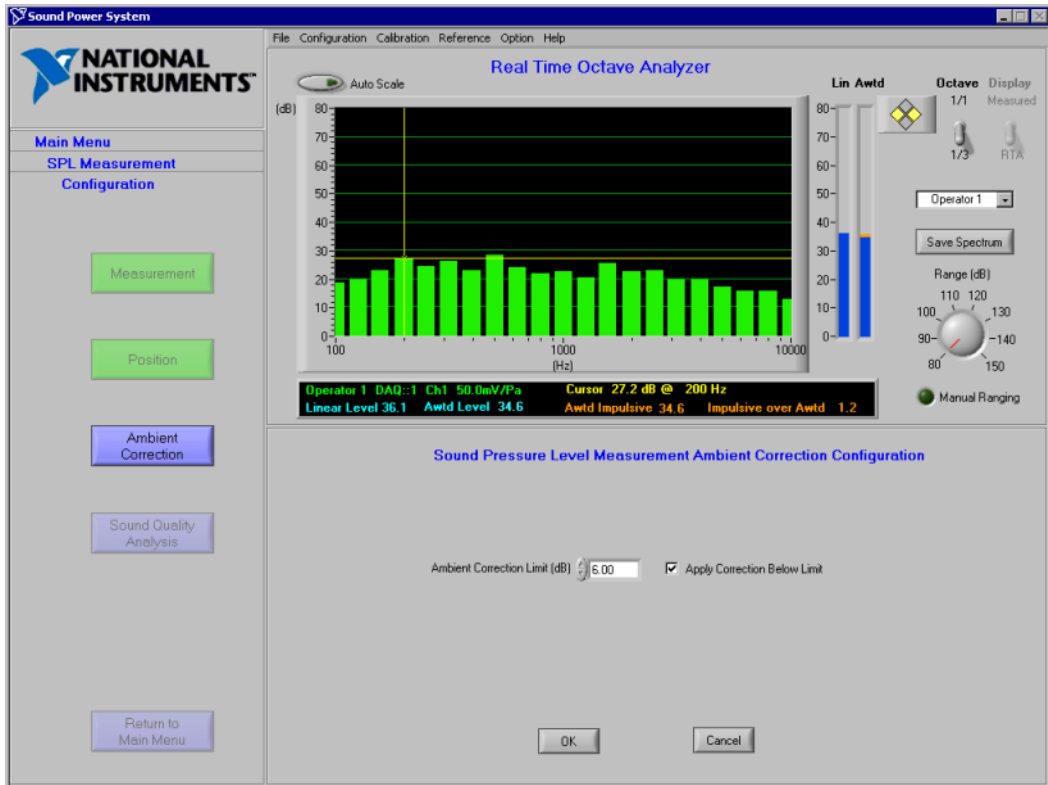


Figure 2-14. Sound Pressure Level Measurement Ambient Correction Configuration Data Window

Use this window to configure how ambient noise corrections are applied to the data. You can access this window in the following ways by selecting **Configuration»Settings»Sound Pressure Level Measurement»Ambient Correction** from the main menu bar or by clicking **Ambient Correction** when the SPL Measurement Configuration flowchart window is active.

In the operator/bystander sound pressure level routine, all ambient noise corrections are applied on a position-by-position basis.

Ambient Correction Limit—Enter a value for the difference between the source and ambient sound pressure levels, below which either no ambient corrections are applied or a fixed correction is applied. The default measurement configuration file has an initial value of 6.0 dB.

Apply Correction Below Limit—Select this check box to apply a fixed correction (equal to the correction that would be applied at the correction limit) to the source sound pressure level data. Select this option if the difference between the source and ambient sound pressure levels is less than the ambient correction limit.

OK—Click this button to accept the values you entered and exit the ambient correction configuration.

Cancel—Click this button to cancel your entries and exit the ambient correction configuration.

Sound Quality Analysis Configuration

Figure 2-15 illustrates the Sound Pressure Level Measurement Sound Quality Analysis Configuration data window.

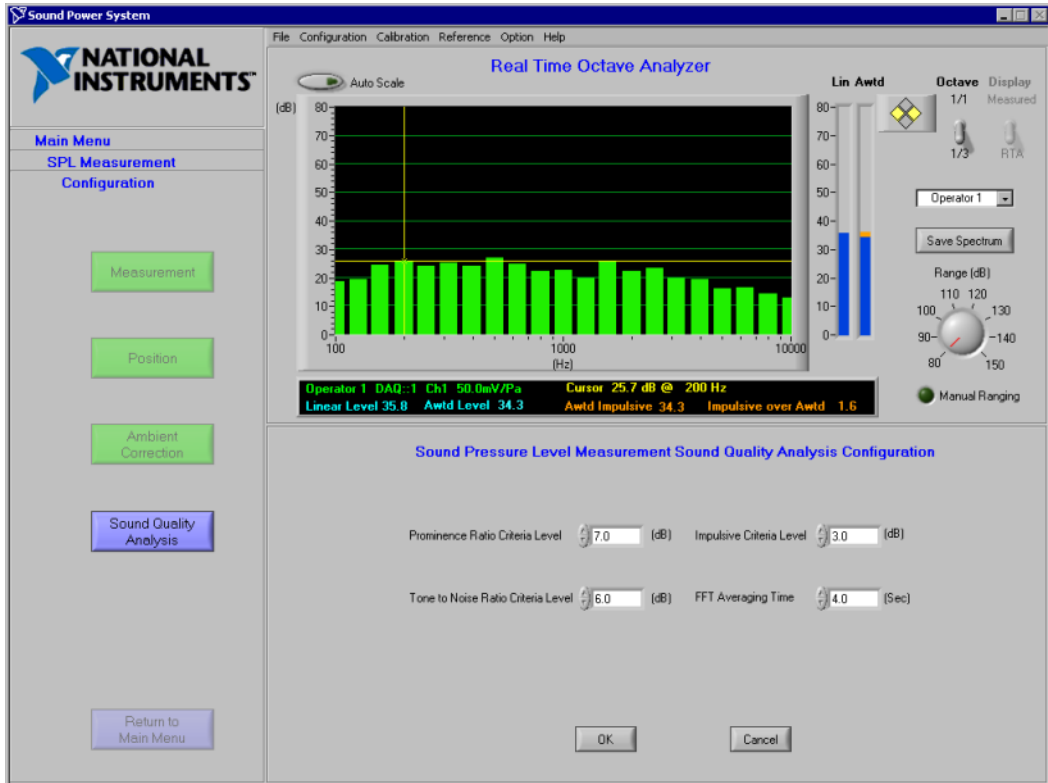


Figure 2-15. Sound Pressure Level Measurement Sound Quality Analysis Configuration Data Window

Use this window to configure the analysis options for the sound quality measurements. You can access this window in the following ways by selecting **Configuration»Settings»Sound Pressure Level Measurement»Sound Quality** from the main menu bar or by clicking **Sound Quality Analysis** when the SPL Measurement Configuration flowchart window is active.

Prominence Ratio Criteria Level—Enter a value (in dB) above which you want a tone analyzed by the prominence ratio method to be flagged as being prominent. An indicator is lit if the ratio exceeds the criteria level. This indicator is in the Prominent Tone Analysis data window. The default

measurement configuration file is set with an initial value of 7.0 dB (see ECMA-74, 1997).

Tone to Noise Ratio Criteria Level—Enter a value (in dB) above which you want a tone analyzed by the tone-to-noise ratio method to be flagged as being prominent. Impulsive sounds are noted by an orange indicator on the position in the Source SPL measurement routine. The default measurement configuration file is set with an initial value of 6.0 dB (see ISO 7779-1988, Annex D, paragraph D.4.5).



Note Tones are automatically analyzed using both the tone-to-noise and prominence ratio methods each time a tone is selected. Indicators provide analysis results for both methods.

Impulsive Criteria Level—Enter a value (in dB) above which you want the difference between the impulse A-weighted sound pressure level and the A-weighted sound pressure level to cause the measurement position to be flagged as being impulsive. The default measurement configuration file is set with an initial value of 3.0 dB (see ISO 7779, Annex D, paragraph D.3.2).

FFT Averaging Time—Enter a value (in seconds) to use as the FFT measurement time while conducting the prominent tone analysis.

OK—Click this button to accept the values you entered and exit the sound quality analysis configuration.

Cancel—Click this button to cancel your entries and exit the sound quality analysis configuration.

Select **Configuration»Save»SPL Measurement Configuration** to save the current operator/bystander sound pressure level measurement configuration data (including sound quality configuration). A dialog box prompts you to enter the name of the file. The file is then saved in the Sound Power Plus native file format. Select **Configuration»Save»Default»SPL Measurement Configuration** if you want to save the current operator/bystander sound pressure level measurement configuration to the system sound pressure level measurement configuration default file `Global_Sound Pressure Level_Default.SPC`.

Auto-Ranging Configuration

Figure 2-16 illustrates the Auto Ranging Configuration data window.

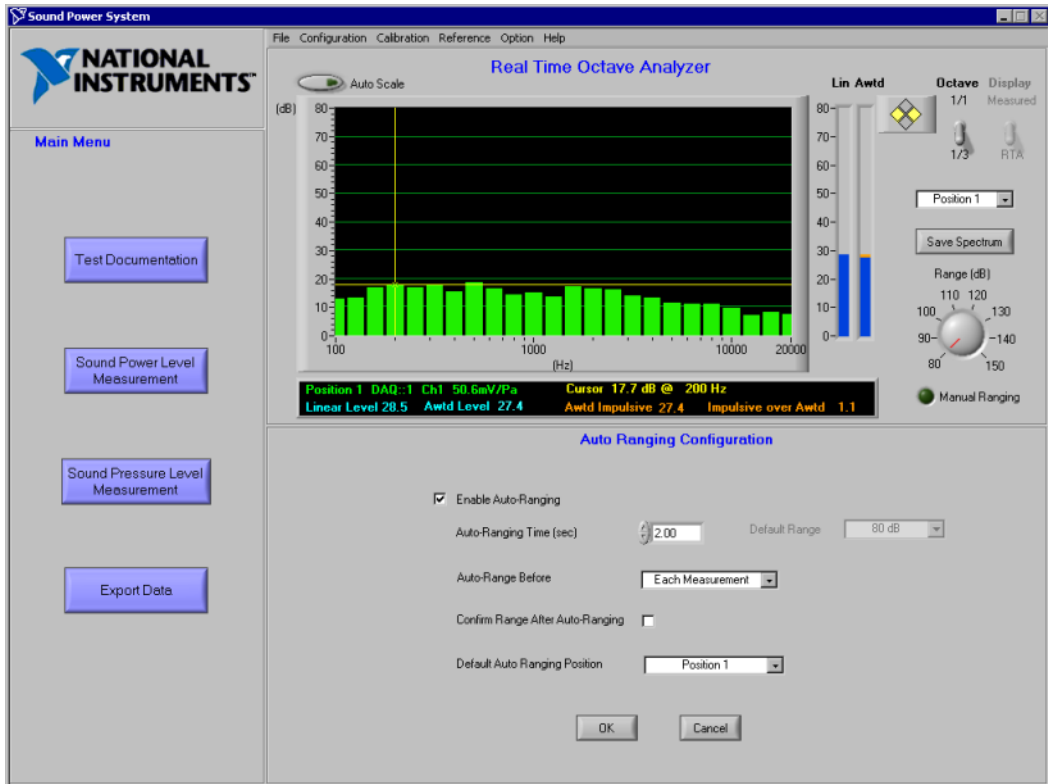


Figure 2-16. Auto Ranging Configuration Data Window

Use this window if you want to automatically set the input range for your instruments based on the sampled signal level. You can access this window by selecting **Configuration»Settings»Auto Ranging** from the main menu bar.

Enable Auto-Ranging—Select this check box if you want to enable auto-ranging on all measurements. When selected, the remaining auto-ranging controls are enabled and the system will automatically determine the proper input range based on the settings you selected. If you do not select this check box, the instrument is automatically set to the default range. If you do not want to use the default range, you must set the

instrument range before each measurement. This is done from the RTA or FFT display window.

Auto Ranging Time (sec)—Enter the length of time (in seconds) you want the system to sample the input signal to automatically determine the proper input range.

Auto Range Before—Sound Power Plus supports two auto-ranging options:

- **Each Measurement**—When you select this option, the software automatically ranges the instrument before each measurement activity, which can include sampling several positions. For example, the instrument would auto-range once before making all ten sound pressure level measurements of a ten-position measurement activity.
- **Each Position**—When you select this option, the software automatically ranges the instrument before taking a measurement at each position.

Confirm Range After Auto-Ranging—When you select this option, you will have the opportunity to confirm or change the automatically selected input range before the measurement proceeds.

Default Range—If auto-ranging is not enabled, this value determines the range that the instrument defaults to before each measurement routine.

Default Auto Ranging Position—If auto-ranging is enabled, all the positions with the same sequence as Default Auto Ranging Position are used as the auto ranging positions before each measurement.

OK—Click this button to accept the values you entered and exit the auto-ranging configuration.

Cancel—Click this button to cancel your entries and exit the auto-ranging configuration.

Documenting Your Test

Sound Power Plus lets you document each test you conduct. To access the test documentation functions, select the **Test Documentation** button from the **Main Menu**. The Test Documentation flowchart appears. The following sections describe the process you use to document the test and equipment.



Note **Test Name** and **Operation Mode** are required documentation fields for all tests.

Test Information

Figure 3-1 illustrates the Test Documentation data window.

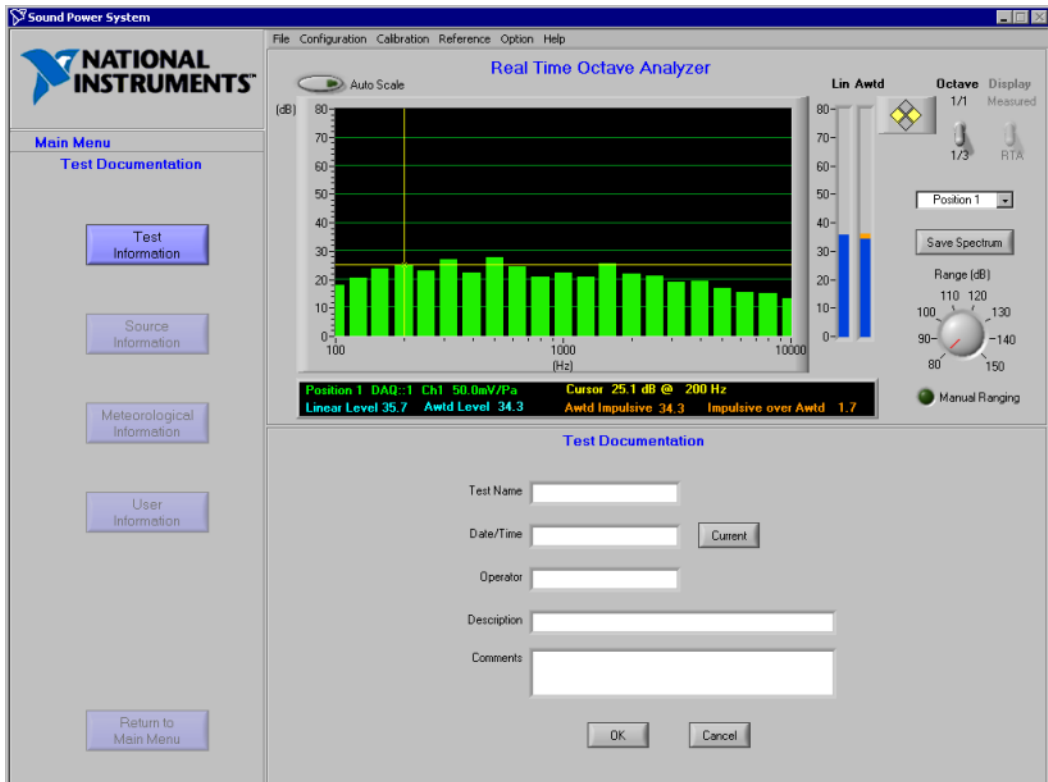


Figure 3-1. Test Documentation Data Window

Use this window to record information about the test being conducted. You can access this window by selecting **Main Menu»Test Documentation** in the flowchart window, then clicking on the **Test Information** button.

Test Name—Enter a unique series of letters and/or numbers that identify the test. The software uses the test name as part of a suggested file name when you save and export to a file. This is a required field.



Note The suggested file name for saving tests is Test Name_Operation Mode.MEA.

Date/Time—Enter the date and time the test was conducted.

Current—Click the **Current** button if you want to enter the current date and time in the **Date/Time** field.

Operator—Enter the name of the operator who conducted the test.

Description—Enter a general description of the test.

Comments—Enter comments about the test.

OK—Click this button to accept the values you entered and exit the test information documentation.

Cancel—Click this button to cancel your entries and exit the test information documentation.

Source Information

Figure 3-2 illustrates Sound Power Plus with the Source Documentation data window active.

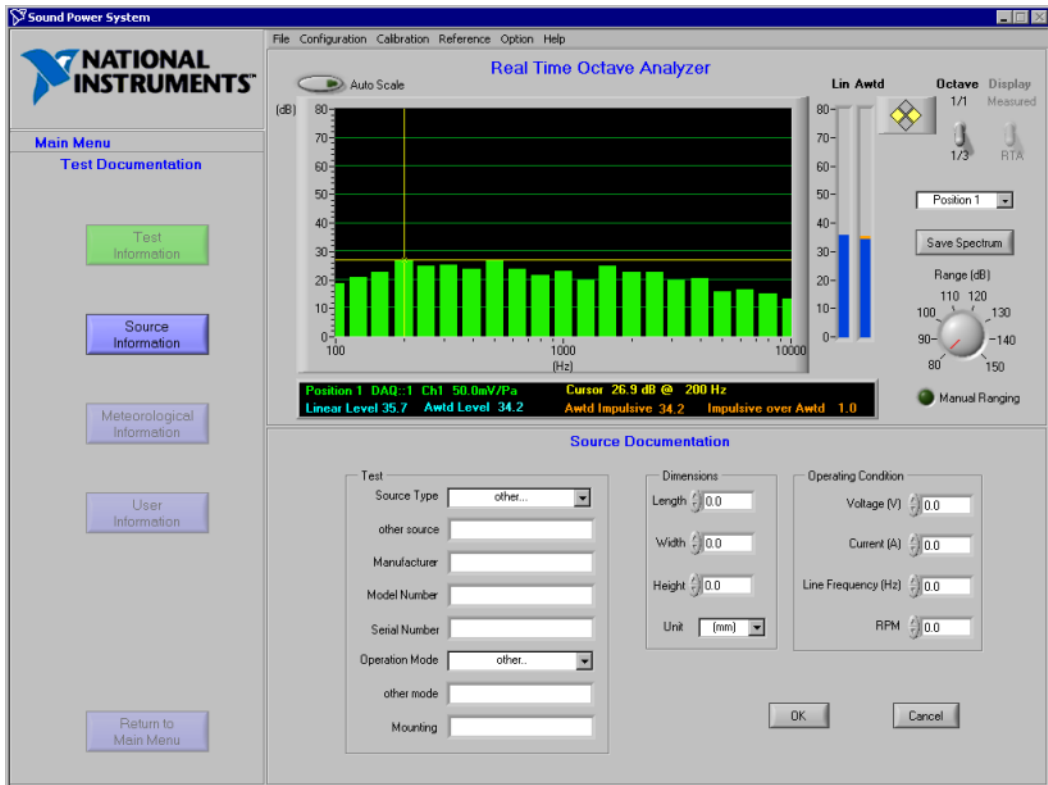


Figure 3-2. Source Documentation Data Window

Use this window to record information about the source being tested. You can access this window by selecting **Main Menu**»**Test Documentation** in the flowchart window, then clicking on the **Source Information** button.

Source Type—Select the type of device being tested. You can modify several common source types which are saved in the configuration file `/Data/Test Information.ini`. These source types are loaded into the list box before you access this window. If you do not find an operation mode suitable for the device you are testing, select **Other** from the **Source Type** list box to enter the name of your operation mode.

Other Source—Enter the name of your source type. This control appears if you selected ‘other...’ for **Source Type**.

Manufacturer—Enter the manufacturer of the device you are testing.

Model Number—Enter the model number of the device you are testing.

Serial Number—Enter the serial number of the device you are testing.

Operation Mode—Select the operation mode of the device you are testing. You can modify several common operation modes which are saved in the configuration file `/Data/Test Information.ini`. These operation modes are loaded into the list box before you access this window. If you do not find an operation mode suitable for the device you are testing, select **Other** from the **Operation Mode** list box to enter the name of your operation mode.

Other Mode—Enter the name of a new operation mode. Enable the **Other Mode** list box by selecting **Other** in the **Operation Mode** list box.



Note The suggested file name for saving tests is `Test Name_Operation Mode`.

Mounting—Enter how the device was mounted during the test.

Dimensions—Enter the **Length**, **Width**, and **Height** measurements of the device, using the units selected in **Unit** control.

Unit—Select the measurement unit for your dimensions. You can choose millimeter, meter, inch or foot. Sound Power Plus automatically sets **Dimensions** to millimeter when you save the data to files or generate reports.

Voltage (V)—Enter the voltage at which you operated the device you are testing.

Current (A)—Enter the current draw for the device you are testing.

Line Frequency (Hz)—Enter the line frequency at which you operated the device you are testing.

RPM—Enter the RPM of the device you are testing.

OK—Click this button to accept the values you entered and exit the source information documentation.

Cancel—Click this button to cancel your entries and exit the source information documentation.

Meteorological Information

Figure 3-3 illustrates Sound Power Plus with the Meteorological Documentation data window active.

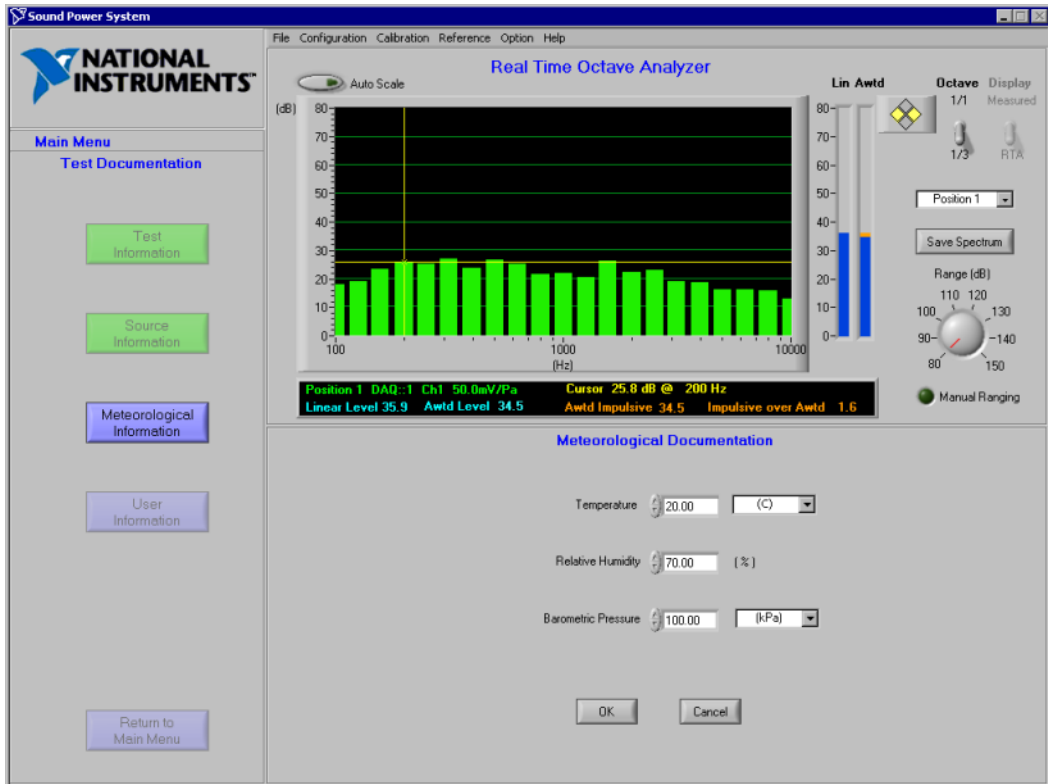


Figure 3-3. Meteorological Documentation Data Window

Use this window to record information about meteorological conditions in the test chamber during the test. Data entered in this form is used to calculate the meteorological correction term, if this option is enabled in the Measurement Options configuration. You can access this window by selecting **Main Menu»Test Documentation** in the flowchart window, then clicking on the **Meteorological Information** button.

Temperature—Enter the temperature (in degrees Celsius or Fahrenheit) in the test chamber at the time of the test.

Temperature Units—Select the units for the temperature value indicated in the **Temperature** field. Sound Power Plus automatically

Relative Humidity (%)—Enter the relative humidity (in percent) in the test chamber at the time of the test.

Barometric Pressure—Enter the barometric pressure (in kPa, hPa, mmHg, or mBar) at the time of the test. Sound Power Plus automatically converts pressure values to kPa when you save data to a file or generate a report.

Barometric Pressure Units—Select the units for the barometric pressure value. Choose from kPa, hPa, mmHg, or millibars. Sound Power Plus automatically converts pressure values to kPa when you click **OK**.

OK—Click this button to accept the values you entered and exit the meteorological information documentation.

Cancel—Click this button to cancel your entries and exit the meteorological information documentation.

User Information

Figure 3-4 illustrates Sound Power Plus with the User Documentation data window active.

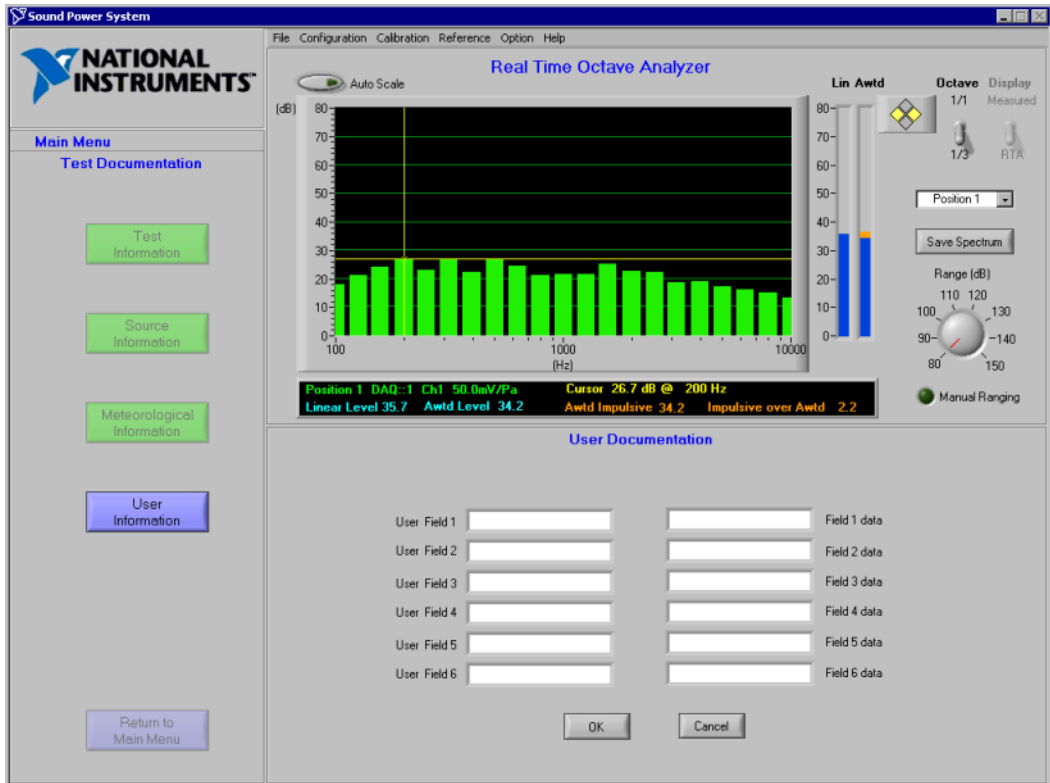


Figure 3-4. User Documentation Data Window

This window provides six user-definable fields that you can use to document custom information about the device being tested. Use the **User Fields** to define the field names and the **Field Data** to record the data for the device being tested. These fields can be renamed from test to test to capture data that is specific to the type of device being tested. You can access this window by selecting **Main Menu**»**Test Documentation** in the flowchart window, then clicking on the **User Information** button.

User Field *n*—The name you assign to the *n*th user field.

Field *n* data—The data associated with **User Field *n***.

OK—Click this button to accept the values you entered and exit the user information documentation.

Cancel—Click this button to cancel your entries and exit the user information documentation.

Save Documentation

Test documentation data is saved along with the sound power or sound pressure level test data when you save the test data files. Select **File» Save Measurement** to save the current test documentation. A dialog box prompts you to enter the name of the file. The file is then saved in the Sound Power Plus native file format.

Test documentation is reloaded into Sound Power Plus when a test file is loaded. To load a data file, select **File» Load Measurement**. Test documentation is also exported when you export data to Excel or text files.

Calibrate Your Microphones

Sound Power Plus includes a calibration routine to calibrate and monitor the calibration sensitivity of the system microphones. This calibration routine is accessible from either the sound power or sound pressure level measurement flowchart.

Sound Power Plus supports manual and automatic calibration routines. The manual calibration routine calibrates each microphone sequentially, requiring you to control the software after each microphone is calibrated. The auto-calibration routine automatically scans the microphones for a calibration signal, calibrates the microphone, and automatically begins scanning for another microphone with a calibration signal. The software provides audible prompts which indicate that a microphone has been calibrated or that a microphone has been scanned and a calibration signal was not detected. The calibration configuration routine provides several control options for the auto-calibration routine.

Calibration Routine Logic

The calibration routine works using the following logic:

1. The nominal sensitivity of each microphone is passed from the microphone data file to the DSA board before the calibration begins.
2. The calibration measurement is performed. The system generates an actual sensitivity offset (in dB) required to cause the microphone to read the calibration level.
3. The system uses the actual sensitivity offset (in dB) to calculate the actual sensitivity of the microphone (in mV/Pa). Prior to all measurements with this microphone, the actual sensitivity calculated is passed to the DSA board and is displayed in the alphanumeric display on the RTA window.
4. A value for the normal sensitivity offset required for the microphone is stored in the microphone data file. The actual sensitivity offset generated during the calibration measurement is compared to this normal sensitivity offset and a difference is generated. This difference is compared to the maximum allowed sensitivity variation that you set in the calibration parameters.

5. During the calibration process, the calibration routine plots the amount the actual sensitivity offset differs from the normal sensitivity offset. You can set a maximum allowed sensitivity variation in the Calibration Configuration parameters. Microphones that calibrate outside of the allowed sensitivity variation appear outside the control range on the graph.

Example

A microphone with a nominal sensitivity of 50 mV/Pa and an actual sensitivity of 45 mV/Pa has a normal sensitivity offset of $20 \log (45/50) = -0.9$ dB.

If, when this microphone is calibrated, a -1.3 dB gain adjustment is required, then the microphone differs by -0.4 dB ($-1.3 - (-0.9) = -0.4$ dB). If the allowable sensitivity variation has been set to 0.3 dB, the calibration level for this microphone is displayed as being outside of the control range on the calibration control chart.

Configuring Calibration

The following sections describe how to configure your microphone calibration.

You can either load calibration data into Sound Power Plus from a file, or enter new calibration data. To load calibration data from a user-named file into the microphone calibration data, select **Calibration»Load Calibration Data**. A dialog box prompts you to enter the name of the file you want to load. The data in the file must match the number of microphones currently configured for the system; otherwise, an error is returned. The file must be in Sound Power Plus native file format.

To enter or change calibration data, launch the calibration configuration routine by selecting **Calibration»Settings**. This launches the Calibration Configuration data window, which lets you change calibration parameters and auto-calibration settings.

Figure 4-1 illustrates Sound Power Plus with the Calibration Configuration data window active.

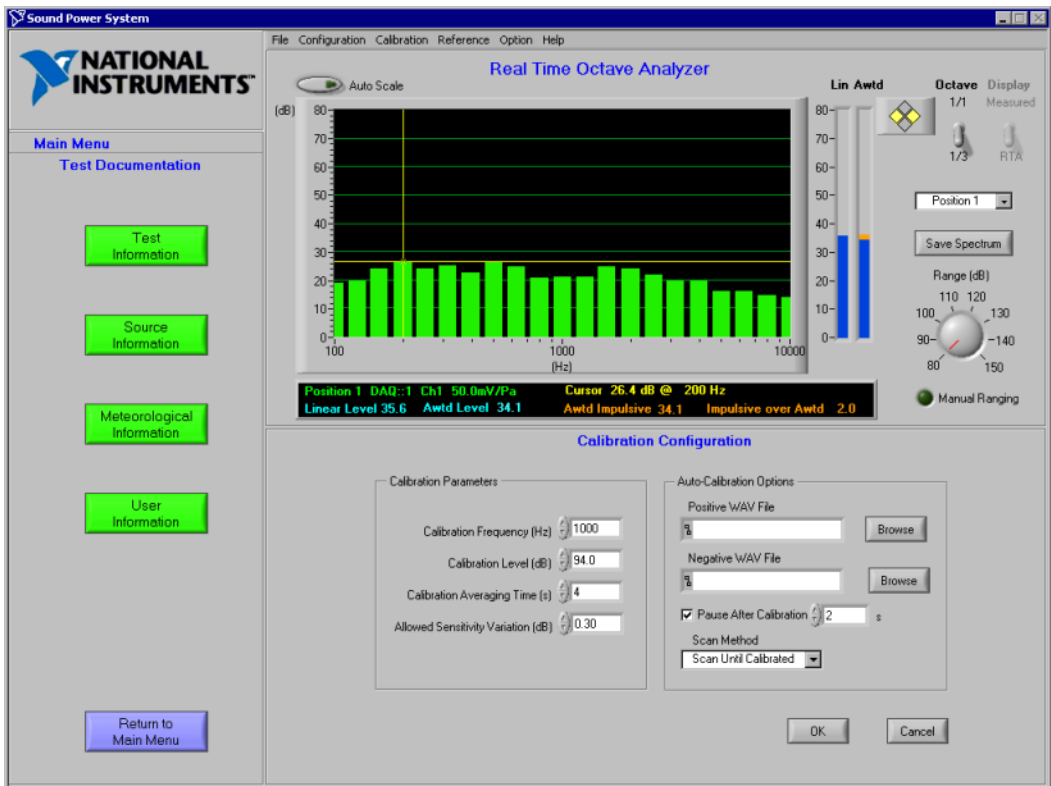


Figure 4-1. Calibration Configuration Data Window

Use this window to configure the microphone calibration parameters and auto-calibration options. You can access this window by selecting **Calibration»Settings** from the main menu bar.

Calibration Parameters

Calibration Frequency (Hz)—The 1/3-octave band center frequency of the calibrator (in Hz).

Calibration Level (dB)—The sound pressure level generated by the calibrator at the calibration frequency (in dB re 2E-5 Pa).

Calibration Averaging Time (s)—The length of the time sample (in seconds) that will be averaged when performing a calibration measurement.

Allowed Sensitivity Variation (dB)—Defines the limits to be applied to the calibration control chart (which is visible when you perform the Microphone Calibration in the next section). This value is the maximum amount (in dB) that the actual sensitivity offset of the microphone may differ from the normal sensitivity offset of the microphone before the calibration control chart indicates that the calibration is out of range.

Auto-Calibration Options

Positive WAV File—A .wav sound file that the system sound card plays whenever the software detects a valid calibration signal during the auto-calibration routine. You can assign any .wav-format file.

Negative WAV File—A .wav sound file that the system sound card plays whenever the software fails to detect a valid calibration signal during the auto-calibration routine. You can assign any .wav-format file.

Pause After Calibration—The duration (in seconds) the system pauses after scanning a microphone for a calibration tone before proceeding to scan the next microphone. This delay is useful if you need to move the calibrator to a new microphone between calibrations. A delay of two to five seconds is usually sufficient for most microphone layouts.

Scan Method—Two scanning methods are supported by the software:

- **Scan Until Calibrated**—The auto-calibration routine scans the microphone for a calibration tone. If no tone is detected, the software pauses, then scans the microphone again. This process is repeated until a calibration tone is detected. The microphone is then calibrated, the software pauses, then proceeds to the next microphone.
- **Sequential Scan**—The auto-calibration routine scans the microphone for a calibration tone. If no tone is detected, the software pauses, then proceeds to scan the next microphone.

OK—Click this button to accept the values you entered and exit the calibration configuration.

Cancel—Click this button to cancel all entries and exit the calibration configuration.



Note Calibration settings are saved with the instrument configuration settings.

Microphone Calibration

Figure 4-2 illustrates Sound Power Plus with the Sound Power Level Measurement Microphone Calibration Configuration data window active.



Note The sound pressure level calibration routine works like the sound power level calibration routine, except that the microphones that are displayed for calibration are the microphones you configured during the sound pressure level measurement configuration.

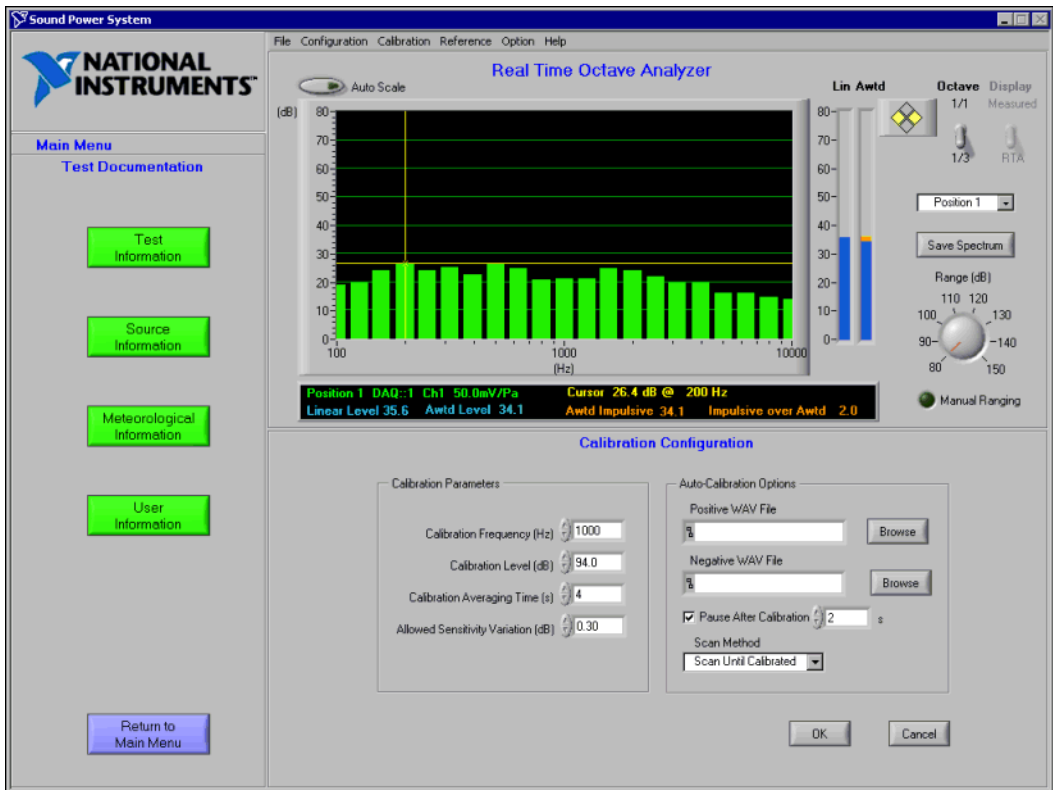


Figure 4-2. Sound Power Level Measurement Microphone Calibration Configuration Data Window

Use this window to calibrate your microphone(s). You can access this window by selecting **Main Menu»Sound Power Level Measurement** in the flowchart window, then clicking on the **Calibration** button.

Calibrate All—Click this control if you want to activate a calibration routine that sequentially calibrates all configured microphones. The **Calibrate All** routine calibrates a microphone, then prompts you to move the calibrator to the next microphone. Click **Continue** to calibrate the next microphone. This sequence continues through all configured microphones.

Auto Calibrate—Click this button if you want to automatically scan all microphones for a calibration tone. If a calibration tone is found, the system stops to calibrate the microphone. If no calibration tone is found, the scanning continues in accordance with the scanning method you configured in the Calibration Configuration. Audible feedback lets you know when a microphone has been successfully calibrated and when no calibration tone is detected.

Calibrate Selected—This procedure operates like **Calibrate All**, but it only scans and calibrates the microphone(s) that have been selected in the Microphone Selection box.

Microphone Selection

The list box on the right side of the screen shows all microphones currently configured and selected for the measurement. You can select any microphone in the list by clicking on the microphone name. To select multiple microphones, press <Shift> while you select the microphone names. Selection of microphones in this manner is used in conjunction with the **Calibrate Selected** control. Clicking on a single microphone in this list also displays its calibration parameters under the **Calibration Control** chart.

Calibration Configuration Parameters

A list of the current calibration parameters is displayed below the **Microphone Selection** list. This list displays the currently configured calibration frequency, calibration level, allowed sensitivity variation, auto-calibration sequence logic, and pause time. For more information on these options, refer to the [Configuring Calibration](#) section of this chapter.

Calibration Control Chart

The **Calibration Control** chart displays the calibration status of each system microphone as it is calibrated. A control range is established based on the allowed sensitivity variation you set in the Calibration Configuration. The 0 dB level for each microphone is based on the normal sensitivity offset for the microphone. The value displayed in this chart

represents the amount the actual sensitivity offset obtained during the calibration measurement differs from the normal sensitivity offset recorded in the microphone sensitivity data file.

Out of Range—If the **Actual Sensitivity Offset** differs from the **Normal Sensitivity Offset** by more than the **Allowed Sensitivity Variation**, the indicator point for the sensitivity of the microphone is shown in red. The value displayed on the control chart is the amount (in dB) by which the **Actual Sensitivity Offset** differs from the **Normal Sensitivity Offset** for the microphone.

Calibration—If the **Actual Sensitivity Offset** differs from the **Normal Sensitivity Offset** by less than or equal to the **Allowed Sensitivity Variation**, the indicator point for the sensitivity of the microphone is shown in green. The value displayed on the control chart is the amount (in dB) by which the **Actual Sensitivity Offset** differs from the **Normal Sensitivity Offset** for the microphone.

Expected—The **Expected** value is indicated by the open green circles along the 0 dB line. All microphones are displayed with an **Expected** value of 0.0 dB, as they are normalized such that the **Normal Sensitivity Offset** of the microphone is indicated by a 0.0 dB calibration value.

Up Limit/Low Limit—The upper and lower limits of the control chart (the allowed sensitivity variation (in dB) from the 0.0 dB **Expected** level) are displayed in dark green. Red data points displayed in these areas indicate that the Actual Sensitivity Offset of the microphone determined during the calibration exceeds the **Normal Sensitivity Offset** of the microphone by more than the allowed sensitivity variation.

OK—Click this button to accept the values you entered and exit the microphone calibration.

Cancel—Click this button to cancel your entries and exit the microphone calibration.

Save Calibration Data

Select **Calibration»Save Calibration Data** to save the current microphone calibration data. A dialog box prompts you to enter the name of the file. This file is then saved in the Sound Power Plus native file format.

Sound Power Level Measurement

The following sections describe how to measure the sound power level. Before you make a sound power level measurement, make sure you have valid instrument and sound power level measurement configuration settings. Refer to the *Configuring Your Instruments* and *Configure A Sound Power Level Measurement* sections in Chapter 2, *Installation and Configuration*, for more information.

You can either load measurement data into Sound Power Plus from a file, or acquire new measurement data. To load measurement data from a file, select **File»Load Measurement**. A dialog box prompts you to enter the name of the file you want to load. The measurement file must match the current measurement configuration; otherwise, an error is returned. The data must be in Sound Power Plus native file format.



Note The current instrument, sound power level, and sound pressure level configuration files are displayed in the data window when the main program menu is active in the flowchart window.

To begin taking sound power level measurements, click the **Sound Power Level Measurement** button on the main flowchart menu. This launches the PWL Measurement flowchart window, from which you can make measurements.

Calibration

Click the **Calibration** button to calibrate and monitor the calibration of the system microphones. This routine is the same in the sound power level measurement flowchart and the sound pressure level measurement flowchart. The calibration routine is described in detail in Chapter 4, *Calibrate Your Microphones*.

Ambient SPL Measurement

Figure 5-1 illustrates Sound Power Plus with the Ambient SPL Measurement data window active.

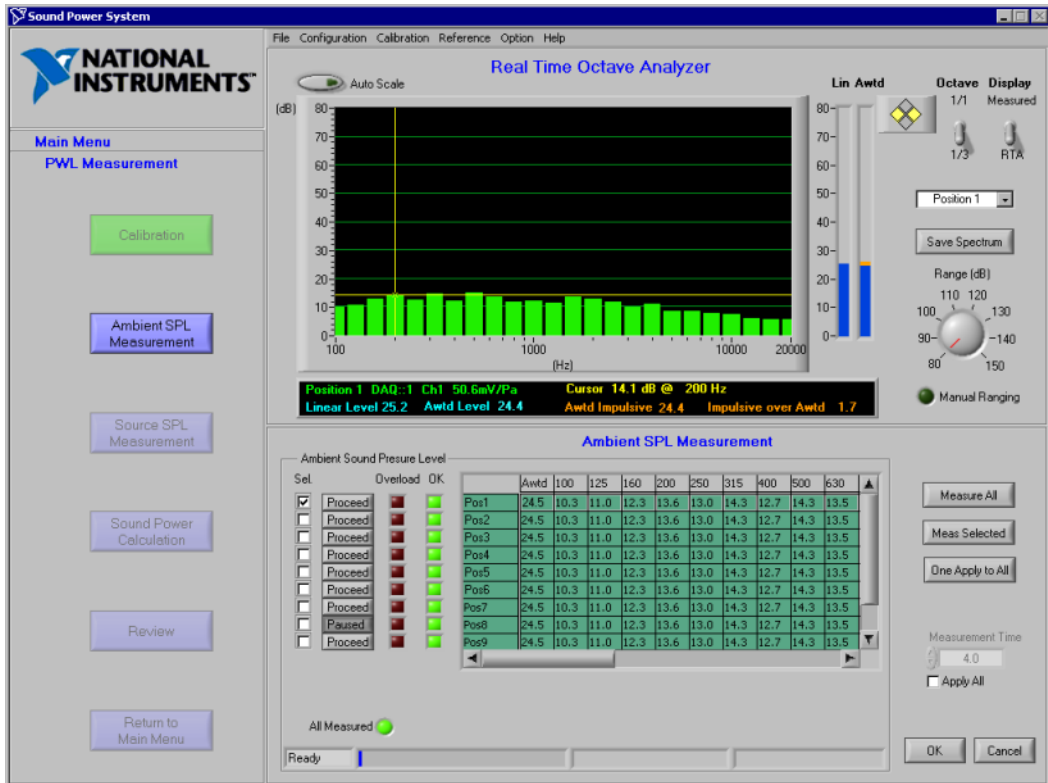


Figure 5-1. Ambient SPL Measurement Data Window

Use this window to measure and review the ambient sound pressure level data. You can access this window by selecting **Main Menu» Sound Power Level Measurement** in the flowchart window, and clicking the **Ambient SPL Measurement** button.

Select—Select a check box to designate the position(s) you want to measure with the **Meas Selected** or **One Apply to All** buttons.

Pause/Proceed—This control determines whether a measurement pauses or proceeds after completing each measurement sequence. A pause in your

measurement sequence is useful when you need to make changes to your setup, such as moving a microphone to a different position.

If any of the controls in a sequence are set to Pause, a prompt appears at the end of the sequence. If all of your controls are set to Proceed, Sound Power Plus starts the next measurement sequence immediately after the current sequence completes.

Overload Indicator—Indicates with a red indicator whether an overload occurred on the input of the DAQ board as the data was acquired. If an overload occurs during an automated measurement sequence, the software attempts to measure the position again before setting the indicator and proceeding. Data with overload indicators set might introduce errors in analysis.

OK Indicator—Indicates with a green indicator whether the data for that position was acquired without overload and if there is valid data for all bands.

Data Table—Ambient sound pressure level data is displayed in the data table as it is obtained. The AwtD sound pressure level is displayed in the first column. This table has scroll bars that let you browse the entire data table. The yellow background of the unmeasured positions changes to green after the measurement is complete.



Note The background color of the data table indicates whether the data in the data table is current data or if it was measured during an earlier visit to this menu. A yellow background indicates that the data was measured during an earlier visit, while a green background indicates that the data is from the current visit.

Measure All—Click this button to sample each measurement position, beginning with Sequence 1 and continuing through the last sequence. Measure All pauses if any of the controls in the current sequence are set to **Pause**.

Meas Selected—Click this button to sample each selected measurement position, starting with the first position and proceeding through all measurement sequences until all selected positions are measured. Meas Selected pauses if any of the controls in the current sequence are set to **Pause**.



Note Sound Power Plus can measure multiple positions at the same time according to the Position Configuration of the measurement. Refer to the [Configure A Sound Power Level Measurement](#) section in Chapter 2, [Installation and Configuration](#), for more information.

One Apply to All—Click this button to make a single sound pressure level measurement at a selected position and copy the measurement result to all positions in the data table. If you select more than one position, the routine measures the first selected position and clears all additional selections.

Measurement Time—If you want to temporarily override the measurement time you set up for each microphone in the Position Configuration, enter the length of time (in seconds) you want the system to sample each position and select **Apply All**. The measurement configuration file in use is not changed.

Apply to All—Use this control to apply **Measurement Time** to all microphones during this measurement session.

All Measured—Indicates whether there is valid data for each configured position.

OK—Click this button to accept the data as it is displayed in the current data table and exit the ambient noise measurement routine.

Cancel—Click this button to return the data to the state it was when you last clicked **OK** and to exit the ambient noise measurement routine.

The status indicator at the bottom of this data window indicates the current status of the DAQ board. Status values are **Ready** or **Acquire**. When you are acquiring data, a status bar indicates the progress of the measurement.

Source SPL Measurement

Figure 5-2 illustrates Sound Power Plus with the Source Sound Pressure Measurement data window active.

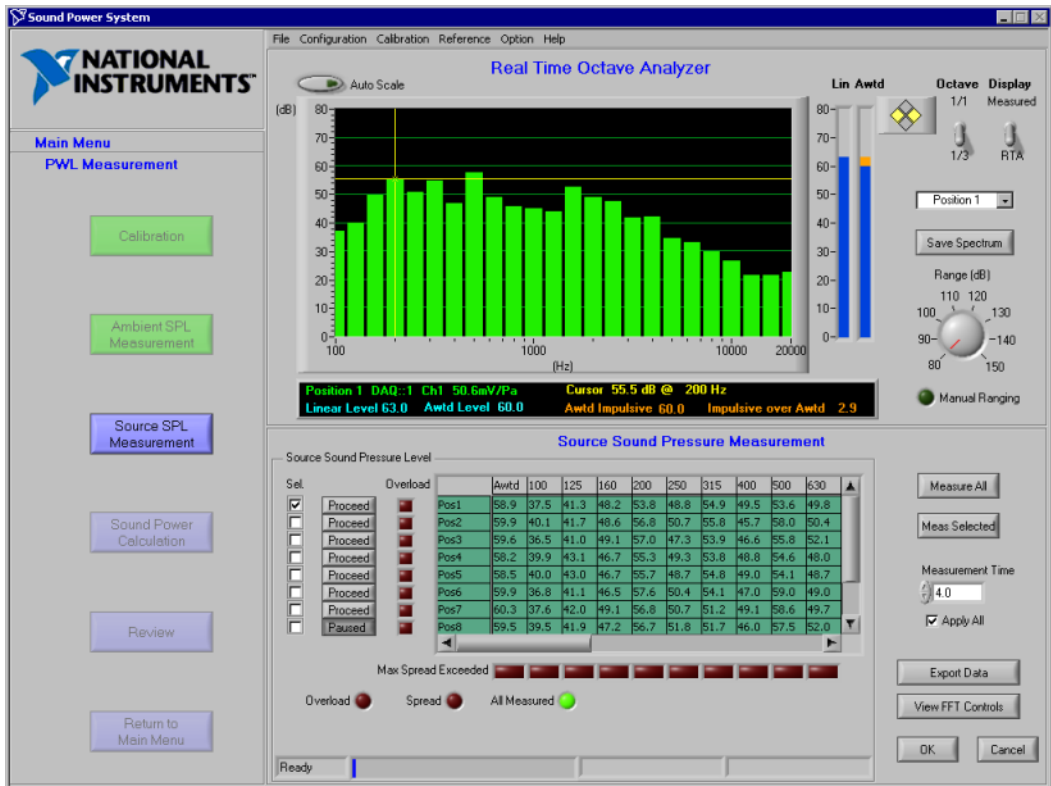


Figure 5-2. Source Sound Pressure Measurement Data Window

Use this window to measure source sound pressure levels. You can access this window by selecting **Main Menu**»**Sound Power Level Measurement** in the flowchart window and clicking **Source SPL Measurement**.



Note Many of the functions in this window are similar to those outlined for ambient sound pressure level measurement.

Select—Select the position(s) you want to measure using the **Measure Selected** control.

Pause/Proceed—This control determines whether a measurement pauses or proceeds after completing each measurement sequence. A pause in your measurement sequence is useful when you need to make changes to your setup, such as moving a microphone to a different position.

If any of the controls in a sequence are set to **Pause**, a prompt appears at the end of the sequence. If all of your controls are set to **Proceed**, Sound Power Plus starts the next measurement sequence immediately after the current sequence completes.

Overload Indicator—If the red indicator next to a position is lit, an overload occurred on the input of the DAQ board as the data was being acquired. Data with overload indicators set might introduce errors in analysis.

Data Table—Source sound pressure level data is displayed in the data table as it is obtained. The AwtD sound pressure level is displayed in the first column. This table has scroll bars that let you browse the entire data table. The yellow background of the unmeasured positions changes to green after the measurement is complete.



Note The background color of the data table indicates whether the data in the data table is current data or if it was measured during an earlier visit to this menu. A yellow background indicates that the data was measured during an earlier visit, while a green background indicates that the data is from the current visit.

Measure All—Click this button to sample each measurement position, beginning with Sequence 1 and continuing through the last sequence. Measure All pauses if any of the controls in the current sequence are set to **Pause**.

Meas Selected—Click this button to sample each selected measurement position, starting with the first position and proceeding through all measurement sequences until all selected positions are measured. Meas Selected pauses if any of the controls in the current sequence are set to **Pause**.



Note Sound Power Plus can measure multiple positions at the same time according to the Position Configuration of measurement. Refer to the [Configure A Sound Power Level Measurement](#) section in Chapter 2, [Installation and Configuration](#), for more information.

Measurement Time—If you want to temporarily override the measurement time you set for each microphone in the Position Configuration, enter the length of time (in seconds) you want the system

to sample each position and select the **Apply All** check box. The measurement configuration file in use is not changed.

Apply All—Select this check box to apply the **Measurement Time** to all microphones during this measurement session.

Max Spread Exceeded—Indicates if the difference between the maximum and minimum sound pressure levels in any band exceeds the number of microphone positions, depending on the max spread flag option you selected in Measurement Option Configuration.

Overload—Notifies you if an overload indicator is present at any position at the end of a measurement sequence with a red light.

Spread—This indicator is lit when the **Max Spread Exceeded** indicator is lit for any frequency band.

All Measured—A green **All Measured** indicator represents valid data for each configured position.

Export Data—Click this button to export source sound pressure data to Excel. After selecting an Excel file as your template file, select a worksheet from the list box as the destination for your exported data. If you do not select **Save To A New File**, the data will be exported to the template file.

View FFT Controls—Click this button to view the Source FFT Measurement data window, which you can use to conduct measurements and view the results of the FFT positions. For more information, refer to the [FFT Measurement](#) section.

OK—Click this button to accept the data as displayed in the current data table and exit the source sound measurement routine.

Cancel—Click this button to return the data to the state it was in the last time you clicked on the **OK** button and exit the source sound measurement routine.

Exporting Data

Figure 5-3 illustrates the Export Source Sound Pressure window. This is an intermediate export of sound pressure level provided by Source Sound Pressure level measurement of Sound Power Level Measurement.

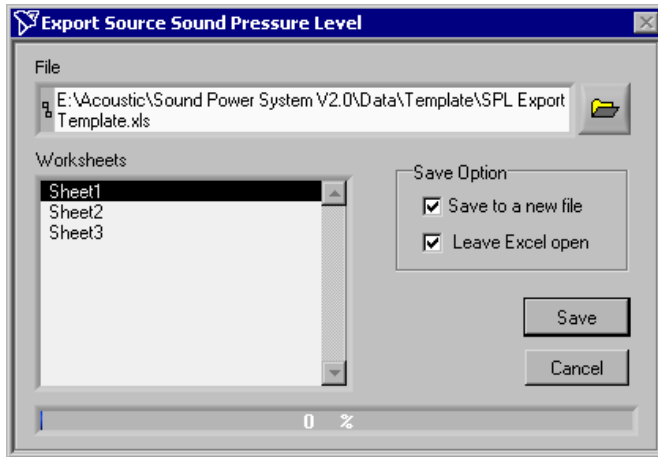


Figure 5-3. Export Source Sound Pressure Window

You can access this window by clicking Export Data to activate the Export to Excel dialog box. This dialog box allows you to select an Excel workbook file and worksheet into which the data will be exported.

Select **File** to display a list of template files for data export. The **Worksheet** control displays a list of the worksheets contained in the template file. If you select one of the Worksheet names and click **Save**, the current Source Sound Pressure Level data is exported into the upper left corner (cell A1) of the Excel workbook, overwriting any existing data in that cell.

Select **Save to a new file** to open an additional dialog box that you can use to rename the Excel file.

Select **Leave Excel open** to leave Excel open once the data export is complete.

The ability to export data is a powerful tool that allows you to use the multi-channel RTA to conduct many custom acoustical tests based on a series of 1/3-octave band sounds pressure level measurements. You can create template files in advance to quickly export data and provide data analysis immediately after the export is complete.



Note If you want to export measurement data from a single Excel file multiple times, select the target file as your template and select worksheets in the **Worksheets** control for exporting data. You can then save data to the file without selecting **Save to a new file**. If you want to edit the Excel file for export at a later time, save the file before exporting data to it. If you export data to an open Excel workbook without first saving any modifications to existing data, you will receive an error message.

FFT Measurement

Figure 5-4 illustrates Sound Power Plus with the Source FFT Measurement data window active.

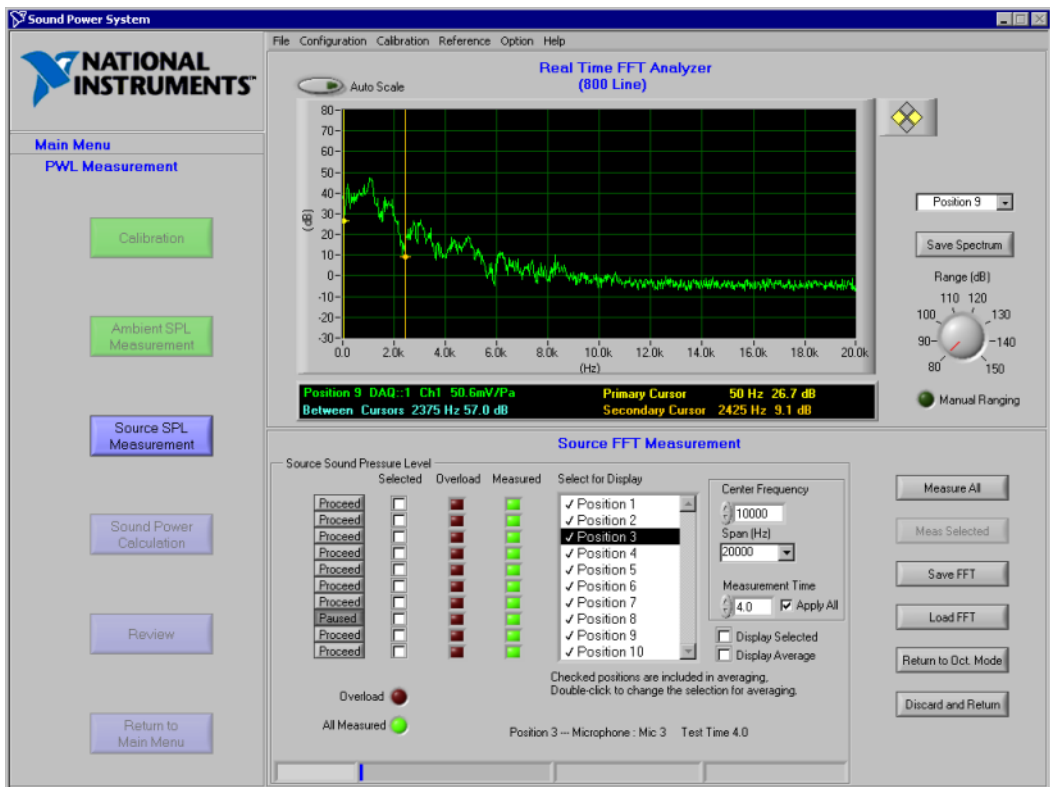


Figure 5-4. Source FFT Measurement Data Window

Use this window to conduct measurements and view the results of the FFT positions you configured for sound power level measurement. The routine also provides an average FFT spectrum that can be configured to calculate and display the average of the FFT spectra at any or all of the measurement

positions. You can access this window by selecting **Main Menu» Sound Power Level Measurement»Source SPL Measurement** in the flowchart window, then clicking the **View FFT Controls** button.



Note The FFT source sound pressure level routine is not required by ISO 7779 and is not a fundamental part of the sound power test. The 1/3-octave band sound power level test results are generated even if no FFT data is acquired.

By default, the configuration parameters on this screen are pulled from the current source sound power level FFT measurement configuration. The values can be changed (but not saved) during the current measurement session.

Pause/Proceed—This control determines whether a measurement pauses or proceeds after completing each measurement sequence. A pause in your measurement sequence is useful when you need to make changes to your setup, such as moving a microphone to a different position.

If any of the controls in a sequence are set to **Pause**, a prompt appears at the end of the sequence. If all of your controls are set to **Proceed**, Sound Power Plus starts the next measurement sequence immediately after the current sequence completes.

Selected—Select a check box to designate the position(s) you want to measure with the **Measure Selected** button.

Overload Indicator—If the red indicator next to a position is lit, an overload occurred on the input of the DAQ board as the data was being acquired. Data with overload indicators set might introduce errors in analysis.

Measured Indicator—If the green **Measured** indicator is lit, there is valid data for the position.

Select for Display—Click the position(s) you want to be displayed on the FFT display.

Center Frequency—This control lets you set the center frequency for the FFT spectrum to be measured.

Span—This control lets you set the frequency range span for the FFT measurement. The span will be centered around the **Center Frequency**.



Note Changes you make to **Center Frequency** and **Span** will be remembered as configuration, but will not be saved to the configuration file. Changes to **Measurement Time** apply to only the current measurement session. Changes to default or named Measurement Configuration files can only be made in Sound Power Level Measurement Configuration.

Measurement Time—If you want to temporarily override the measurement time you set for each microphone in the **Position Configuration**, enter the length of time (in seconds) you want the system to average the FFT at each position.

Apply All—Select this check box to apply the **Measurement Time** to all positions during this measurement.

Display Selected—Select this check box if you want to display the positions selected in the Select for Display field.

Display Average—Select this check box if you want to display the average FFT spectrum of the positions selected for inclusion in the average FFT spectrum.

Overload—If an overload indicator is present at any position at the end of a measurement sequence, this indicator lights red.

All Measured Indicator—If the green **All Measured** indicator is lit, there is valid data for each configured position.

Measure All—Click this button to conduct an FFT at each measurement position, beginning with Measurement Sequence 1 and continuing through the last measurement sequence. This sequence pauses if the **Paused/Proceed** button is in the **Paused** mode.

Measure Selected—Click this button if you want to conduct an FFT at each selected measurement position, starting with the first selected position and proceeding through all selected positions. This sequence pauses if the **Paused/Proceed** button is in the **Paused** mode.



Note Sound Power Plus can measure multiple positions at the same time according to Position Configuration of measurement. Refer to the [Configure A Sound Power Level Measurement](#) section in Chapter 2, *Installation and Configuration*, for more information.

Save FFT—Click this button to save one or more of the current FFT spectra to a file. A selection box appears that lets you choose FFT spectra by clicking on the positions to be saved. Hold the <Shift> key while

clicking to select multiple positions. For more information on FFT file export format, refer to Appendix B, *Program and Data Files*.

Load FFT—Click this button to load FFT spectra from a file. A selection box appears that lets you choose FFT spectra by clicking on the positions to be loaded. Hold the <Shift> key while clicking to select multiple positions. For more information on FFT file format, refer to Appendix B, *Program and Data Files*.



Note FFT data files are saved and loaded independent of the sound power or sound pressure measurement file. The save and load buttons on this screen provide the only method of saving and loading FFT data files.

This FFT file contains position and frequency range information. When you load FFT, Sound Power Plus checks the frequency range of current measurement and the selected FFT file. You can *only* load FFT when both frequency ranges are the same. For example, you can only load the FFT of Position 1 in the file to Position 1 of the current measurement. Sound Power Plus does not load the FFT of the position, which is out of range of the current measurement.

Return to Oct Mode—Click this button to accept the data as displayed and exit the FFT measurement.

Discard and Return—Click this button to return the data to the state it was in the last time the **Return to Octave Mode** button was activated and exit the FFT measurement.

FFT Cursors

The FFT Sound Pressure Level Measurement routine provides two cursors that you can use to examine the FFT spectra.

The cursors are initially located along the Y-axis of the FFT display. To access the cursor, click your mouse in the FFT display window. A cross hair will appear. Place this cross hair over the primary (yellow) cursor and use it to drag the cursor to the desired position on the FFT plot. The secondary (orange) cursor is accessed and moved in the same manner. Fine movements of the cursors can be made using the yellow left and right arrow controls at the upper right of the FFT display window.

The FFT cursors can be locked to any displayed FFT spectra. The dots on each cursor indicate which FFT spectra the cursor is currently locked on. The dot can be moved from spectrum to spectrum by using the green and

brown up and down arrow controls at the upper right of the FFT display window.

Sound Power Calculation

Figure illustrates Sound Power Plus with the Sound Power Level Calculation data window active.

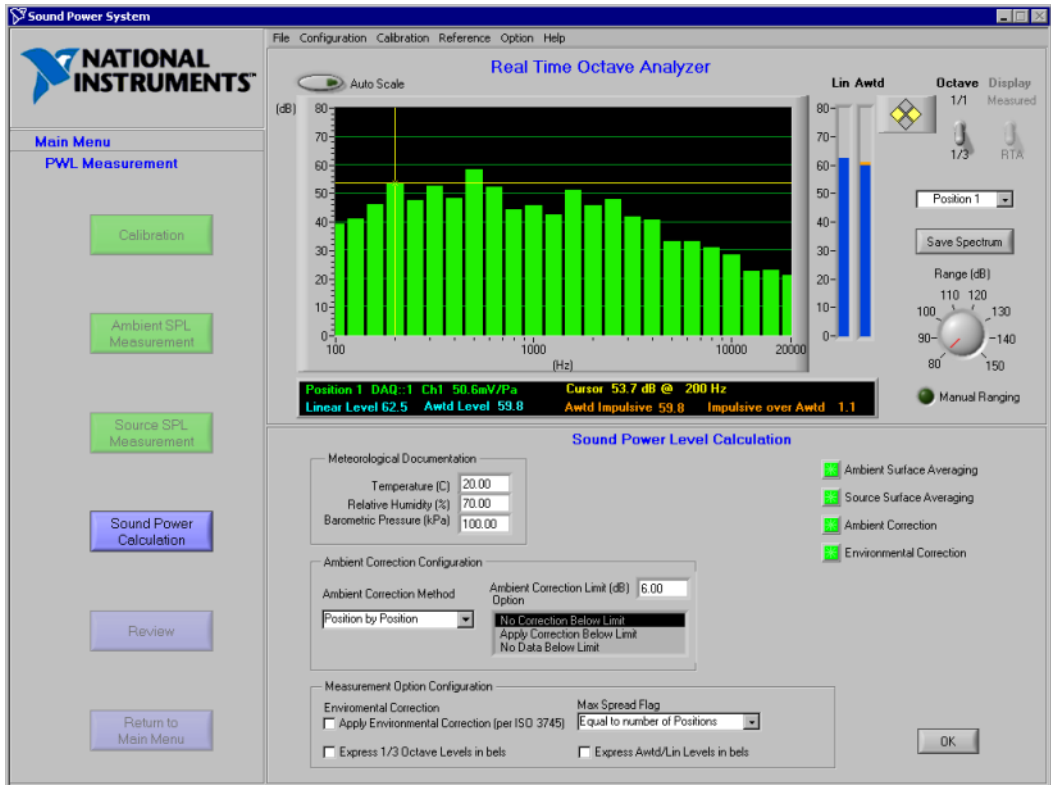


Figure 5-5. Sound Power Level Calculation Data Window

This window is displayed when sound power level results are calculated. You can access this window by selecting **Main Menu»Sound Power Level Measurement** in the flowchart window, then clicking on the **Sound Power Calculation** button.

This window displays the currently configured measurement parameters that are used to make the sound power calculation. These parameters are configured in the sound power Measurement Configuration.

This window displays a series of status indicators. When lit green, these indicators show the following calculations were made correctly:

- **Ambient Surface Averaging**—Valid ambient sound pressure level data resulted in calculation of valid surface average values.
- **Source Surface Averaging**—Valid source sound pressure level data resulted in calculation of valid surface average values.
- **Ambient Correction**—Ambient noise corrections resulted in valid corrected source sound pressure level data.
- **Environmental Correction**—Valid environmental correction data was applied to the corrected surface average sound pressure levels.

Meteorological Documentation

Temperature (C)—The temperature (in degrees Celsius) in the test chamber at the time of the test.

Relative Humidity (%)—The relative humidity (in percent) in the test chamber at the time of the test.

Barometric Pressure (kPa)—The barometric pressure (in kPa) at the time of the test.

Ambient Correction Configuration

Ambient Correction Method—Method (Position by Position or Surface Average) in which ambient noise corrections are made.

Ambient Correction Limit (dB)—The difference between the source and ambient sound pressure levels, below which either no ambient corrections are applied or a fixed correction is applied.

Option—Ambient correction method (No Correction Below Limit, Apply Correction Below Limit, or No Data if Below Limit) to apply if the difference between ambient and source exceeds the limit you set.

Measurement Option Configuration

Apply Environmental Correction—Indicates whether you applied the correction term based on temperature and barometric pressure.

Max Spread Flag—A maximum limit to the difference between the maximum and minimum sound pressure levels as a function of the number of measurement positions (Equal to the Number of Measurement Positions, or Equal to Half the Number of Measurement Positions).

Express 1/3 Octave Sound Power Levels in bels—Calculates all 1/3-octave band sound power level results in bels (1 bel = 10 dB).

Express Awtd/Lin Levels in bels—Calculates the Awtd and linear sound power level results in bels (1 bel = 10 dB).

OK—Click this button to accept the data as displayed in the current data table and exit the sound power calculation routine.

Review

Figure 5-6 shows Sound Power Plus with the Sound Power Level Report data window active.

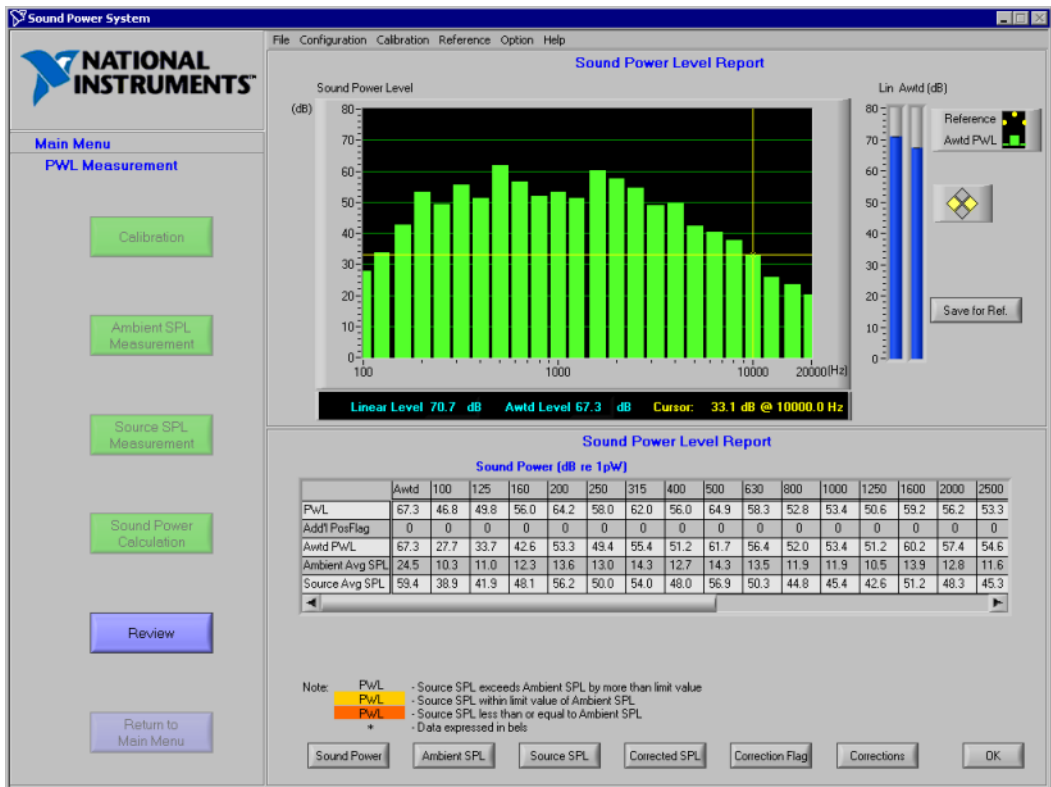


Figure 5-6. Sound Power Level Report Data Window

Use this window to calculate the sound power and display the results. You can access this window by selecting **Main Menu»Sound Power Level Measurement** in the flowchart window, then clicking on the **Review** button.

Click the buttons at the bottom of the window to access the details of the sound power calculation. For more information about how the calculations are made, refer to Appendix A, *Configuration Concepts, Protocols, and Calculations*.

The results are displayed in the data table. For convenience, the A-weighted value is displayed in the leftmost column.

The results are displayed in a graphical form in the graphic window. If you entered reference spectrum, it can be displayed on the same graph.

Sound Power—Click this button to display the sound power test results and the associated flags. Ambient correction flags in this view are expressed by coloring the data affected by ambient interference as described in the legend.

Ambient SPL—Click this button to display the ambient sound pressure levels at each measurement position and the surface average ambient SPL.

Source SPL—Click this button to display the source sound pressure levels at each measurement position and the surface average source SPL.

Corrected SPL—Click this button to display the corrected ambient source sound pressure levels at each position and the surface average corrected ambient SPL.

Correction Flag—Click this button to display the ambient status flags for each position, the surface average, and any additional position status. Ambient correction flags in this view are expressed in terms of a condition code as described in the legend. These conditions codes are included with the exported data.

Corrections—Click this button to display the corrections applied to the test data to account for the effect of the test environment and meteorological conditions.

OK—Click this button to return to the Sound Power Main Menu.

Save Measurement

Select **File»Save Measurement** to save the current test documentation and measurement data. A dialog box prompts you to enter the name of the file. The file is then saved in the Sound Power Plus native file format. Refer to Appendix B, *Program and Data Files*, for a discussion of file formats.

Sound Pressure Level Measurement

The following sections describe how to measure operator and bystander sound pressure levels in accordance with the procedures of ISO 7779. Before you take a sound pressure level measurement, ensure that you have valid instrument and sound pressure level measurement configuration settings. Refer to the [Configuring Your Instruments](#) and [Configure A Operator/Bystander Sound Pressure Level Measurement](#) sections in Chapter 2, [Installation and Configuration](#), for more information.

You can either load measurement data into Sound Power Plus from a file, or acquire new measurement data. To load measurement data from a file, select **File»Load Measurement**. A dialog box prompts you to enter the name of the file you want to load. The measurement file must match the current measurement configuration; otherwise, an error is returned. The data must be in Sound Power Plus native file format.



Note The current instrument, sound power level, and sound pressure level configuration files are displayed in the data window when the main program menu is active in the flowchart window.

To begin taking sound pressure level measurements, click the **Sound Pressure Level Measurement** button on the main flowchart menu. This launches the SPL Measurement flowchart window, from which you can make measurements.

Calibration

Click the **Calibration** button to calibrate and monitor the calibration of the system microphones. The sound pressure level calibration routine works like the sound power level calibration routine, except that the microphones that are displayed for calibration are the microphones you configured during the sound pressure level measurement setup. The calibration routine is described in detail in Chapter 4, [Calibrate Your Microphones](#).

Ambient SPL Measurement

Figure 6-1 illustrates Sound Power Plus with the Ambient SPL Measurement data window active.

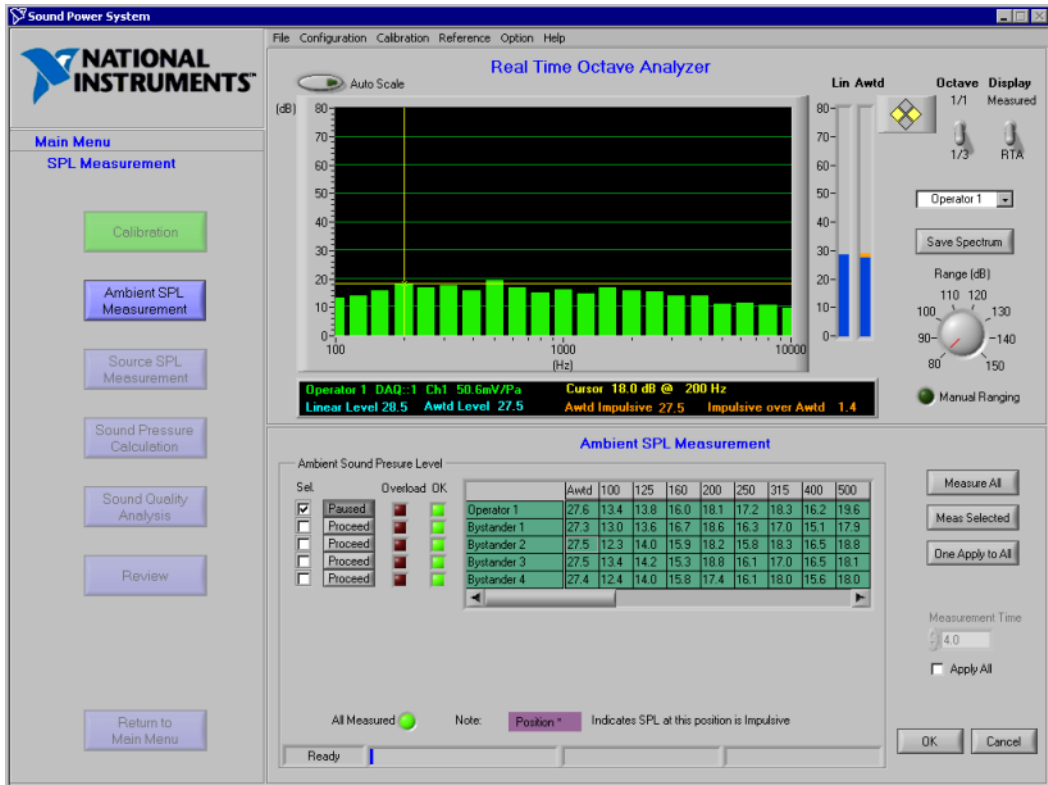


Figure 6-1. Ambient SPL Measurement Data Window

Use this window to measure and review ambient sound pressure level data. You can access this window by selecting **Main Menu»Sound Pressure Level Measurement** in the flowchart window, then clicking the **Ambient SPL Measurement** button.



Note The ambient sound pressure level measurement routine and controls work like the sound power level ambient sound pressure level measurement routine. The only difference is that ambient sound pressure levels are only acquired for the positions configured during the sound pressure level measurement configuration.

Select—Select a check box to designate the position(s) you want to measure with the **Meas Selected** or **One Apply to All** buttons.

Pause/Proceed—This control determines whether a measurement pauses or proceeds after completing each measurement sequence. A pause in your measurement sequence is useful when you need to make changes to your setup, such as moving a microphone to a different position.

If any of the controls in a sequence are set to **Pause**, a prompt appears at the end of the sequence. If all of your controls are set to **Proceed**, Sound Power Plus starts the next measurement sequence immediately after the current sequence completes.

Overload Indicator—If the red indicator next to any position is lit, an overload occurred on the input of the DAQ board as the data was being acquired. If an overload occurs during an automated measurement sequence, the software attempts to re-measure the position before setting the indicator and proceeding. Data with overload indicators set might introduce errors in analysis.

OK Indicator—If the green indicator next to a position is lit, the data for that position was acquired without overload and there is valid data for all bands.

Data Table—Ambient sound pressure level data is displayed in the data table as it is obtained. The AwtD sound pressure level is displayed in the first column. This table has scroll bars that let you browse the entire data table. The yellow background of the unmeasured positions changes to green after the measurement is complete.

Measure All—Click this button to sample each measurement position, beginning with Measurement Sequence 1 and continuing through the last measurement sequence. This sequence pauses if the **Paused/Proceed** button is in the **Paused** mode.

Meas Selected—Click this button to sample each selected measurement position, starting with the first selected position and proceeding through all selected positions. This sequence pauses if the **Paused/Proceed** button is in the **Paused** mode.



Note Sound Power Plus can measure multiple positions at the same time according to Position Configuration of measurement. Refer to the [Configure A Sound Power Level Measurement](#) section in Chapter 2, [Installation and Configuration](#), for more information.

One Apply to All—Click this button if you want to make a single sound pressure level measurement at a selected position and copy the measurement result to all positions in the data table. If more than one position is selected, the routine measures the first position selected and clears all additional selections.

Measurement Time—If you want to temporarily override the measurement time you set for each microphone in the Position Configuration, enter the length of time (in seconds) you want the system to sample each position and select the **Apply All** check box. The measurement setup file in use is not changed.

Apply to All—Select this check box to apply the **Measurement Time** to all microphones during this measurement session.

All Measured—If the green **All Measured** indicator is lit, there is valid data for each configured position.

OK—Click this button to accept the data as displayed in the current data table and exit the ambient sound measurement routine.

Cancel—Click this button to return the data to the state it was in the last time you clicked on the **OK** button and exit the ambient sound measurement routine.

Operator/Bystander Source SPL Measurement

Figure 6-2 illustrates Sound Power Plus with the Source Sound Pressure Measurement data window active.

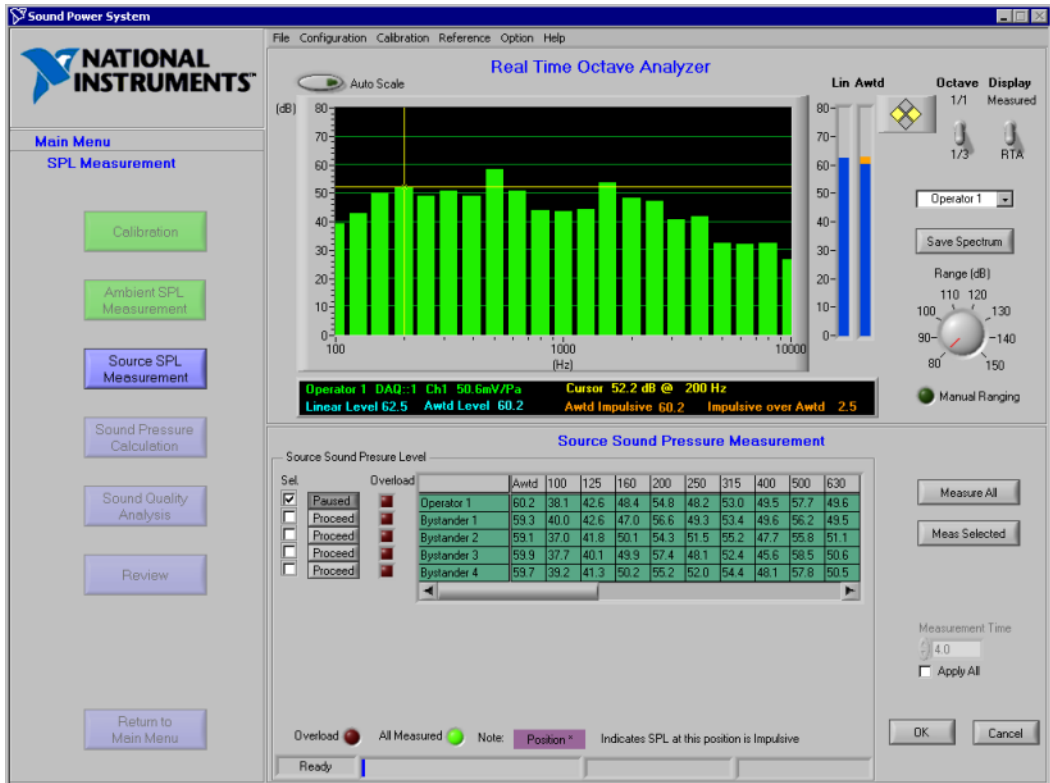


Figure 6-2. Source Sound Pressure Measurement Data Window

Use this window to measure operator and bystander position sound pressure levels. You can access this window by selecting **Main Menu**» **Sound Pressure Level Measurement** in the flowchart window, then clicking the **Source SPL Measurement** button.



Note Many of the functions in this window are similar to those outlined for ambient sound pressure level measurement.

If a purple bar appears over the position in the data table, the impulsive noise criteria was exceeded, as calculated in the following equation:

$$(L_{\text{EqAI}} - L_{\text{EqA}}) > \text{Impulsive Criteria Level}$$

Select—Select a check box to designate the position(s) you want to measure with the **Measure Selected** button.

Pause/Proceed—This control determines whether a measurement pauses or proceeds after completing each measurement sequence. A pause in your measurement sequence is useful when you need to make changes to your setup, such as moving a microphone to a different position.

If any of the controls in a sequence are set to **Pause**, a prompt appears at the end of the sequence. If all of your controls are set to **Proceed**, Sound Power Plus starts the next measurement sequence immediately after the current sequence completes.

Overload Indicator—If the red indicator next to any position is lit, an overload occurred on the input of the DAQ board as the data was being acquired. If an overload occurs during an automated measurement sequence, the software attempts to re-measure the position before setting the indicator and proceeding. If an overload indicator is present at any position at the end of a measurement sequence, the overload indicator at the bottom of the data window lights red. Data with overload indicators set might introduce errors in analysis.

Data Table—Operator and bystander sound pressure level data is displayed in the data table as it is obtained. The Awtd sound pressure level is displayed in the first column. This table has scroll bars that let you browse the entire data table. The yellow background of the unmeasured positions changes to green after the measurement is complete.



Note The background color of the data table indicates whether the data in the data table is current data or if it was measured during an earlier visit to this menu. A yellow background indicates that the data was measured during an earlier visit, while a green background indicates that the data is from the current visit.

Measure All—Click this button to sample each measurement position, beginning with Sequence 1 and continuing through the last sequence. Measure All pauses if any of the controls in the current sequence are set to **Pause**.

Meas Selected—Click this button to sample each selected measurement position, starting with the first position and proceeding through all measurement sequences until all selected positions are measured. Meas Selected pauses if any of the controls in the current sequence are set to **Pause**.



Note Sound Power Plus can measure multiple positions at the same time according to Position Configuration of measurement. Refer to the [Configure A Sound Power Level Measurement](#) section in Chapter 2, [Installation and Configuration](#), for more information.

Measurement Time—If you want to temporarily override the measurement time you set for each microphone in the measurement setup, enter the length of time (in seconds) you want the system to sample each position and select the **Apply All** check box. The measurement configuration file in use is not changed.

Apply All—Select this check box to apply the **Measurement Time** to all microphones during this measurement session.

Overload—If an overload indicator is present at any position at the end of a measurement sequence, this indicator lights red.

All Measured—If the green **All Measured** indicator is lit, there is valid data for each configured position.

OK—Click this button to accept the data as displayed in the current data table and exit the source sound pressure level measurement.

Cancel—Click this button to return the data to the state it was in the last time you clicked on the **OK** button and exit the source sound pressure level measurement.

Sound Pressure Calculation

Figure 6-3 illustrates Sound Power Plus with the Sound Pressure Level Calculation data window active.

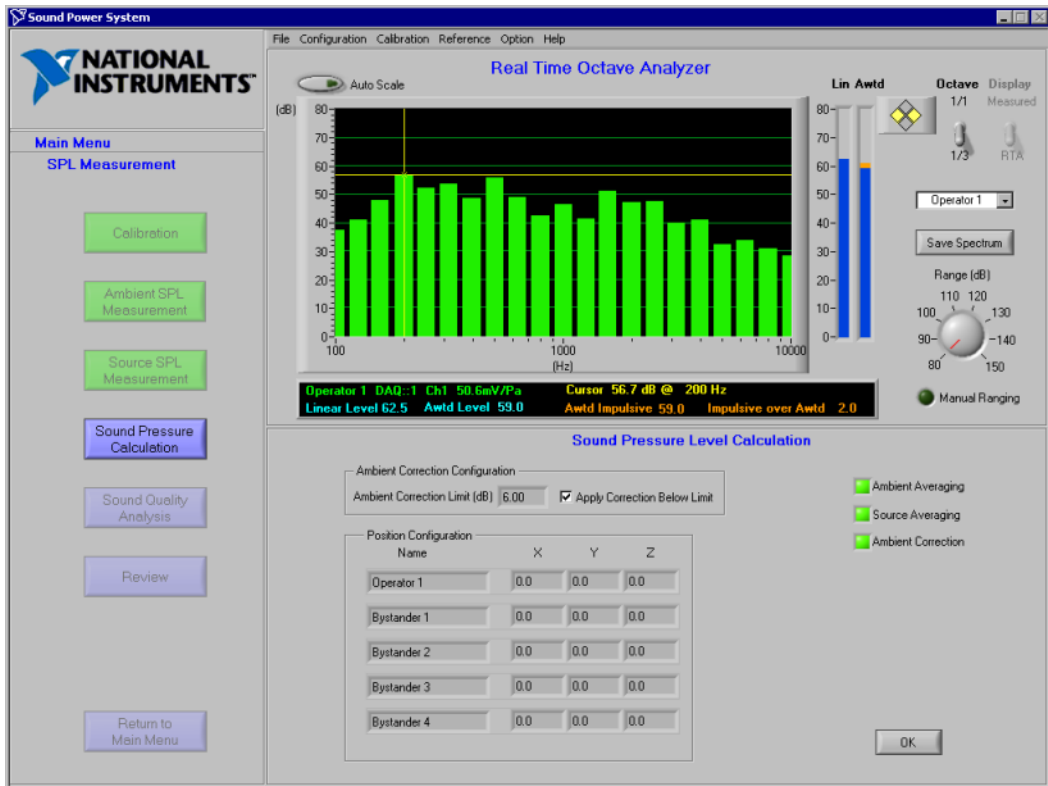


Figure 6-3. Sound Pressure Level Calculation Data Window

This window is displayed when sound pressure level results are calculated. You can access this window by selecting **Main Menu»Sound Pressure Level Measurement** in the flowchart window, then clicking on the **Sound Pressure Calculation** button.

This window displays the currently configured measurement parameters that are used to make the sound pressure calculation. These parameters are configured in the sound pressure measurement configuration. For more information on each of the configuration parameters, refer to the sound pressure Measurement Configuration.

This window displays a series of status indicators. When lit green, these indicators show the following calculations were made correctly:

- **Ambient Averaging**—Valid ambient sound pressure level data resulted in calculation of valid surface average values.
- **Source Averaging**—Valid source sound pressure level data resulted in calculation of valid surface average values.
- **Ambient Correction**—Ambient noise corrections resulted in valid corrected source sound pressure level data.

Ambient Correction Configuration

Ambient Correction Limit (dB)—The difference between the source sound pressure level and ambient sound pressure level, below which either no ambient corrections are applied or a fixed correction is applied.

Apply Correction Below Limit—Ambient correction method to apply if the difference between ambient and source exceeds the limit you set.

Position Configuration

Name—Lists selected operator and bystander positions.

X, Y, Z—Coordinates for each measurement position in meters, as defined in the Sound Pressure Level Measurement Position Configuration.

OK—Click this button to accept the data as displayed in the current data table.

Sound Quality Analysis

Figure 6-4 illustrates Sound Power Plus with the Prominent Tone Listening Test data window active.

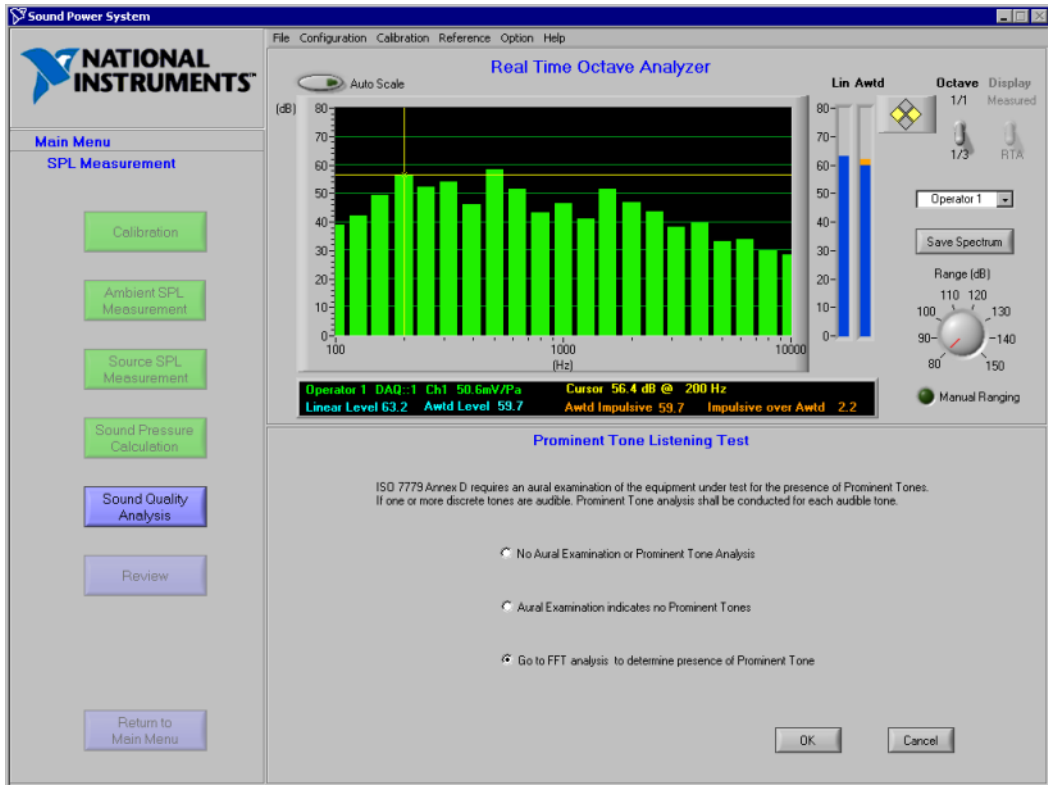


Figure 6-4. Prominent Tone Listening Test Data Window

Use this window to document the status of prominent tone listening tests. You can access this window by selecting **Main Menu»Sound Pressure Level Measurement** in the flowchart window, then clicking on the **Sound Quality Analysis** button. For more information about sound quality analysis, refer to the *Sound Quality Analysis Calculations* section in Appendix A, *Configuration Concepts, Protocols, and Calculations*.



Note You must select the **Go to FFT analysis to determine presence of Prominent Tone** check box to access the prominent tone analysis routine.

No Aural Examination or Prominent Tone Analysis—If you do not enter this routine during a test, the data file indicates that no aural (listening) test was conducted and that you did not use the FFT routine to determine whether prominent discrete tones were present. By default, this check box is selected.

Aural Examination indicates no Prominent Tones—This check box lets you document that an aural examination of the equipment under test was conducted and that no prominent discrete tones were audibly present.

Go to FFT Analysis to determine presence of Prominent Tone—This check box lets you document that FFT-based prominent tone analysis was used to determine whether prominent discrete tones were present. After you select this option, click **OK** to view the Prominent Tone Analysis window, which you can use to conduct prominent tone analysis on configured and measured operator/bystander positions. For more information, refer to the *Prominent Tone Analysis* section.

OK—Click this button to accept the data and exit the prominent tone listening test.

Cancel—Click this button to revert to the previously saved data and exit the prominent tone listening test.



Note If you attempt to change the state of the prominent tone listening test check boxes after an FFT prominent analysis has been conducted, the prominent tone table will be cleared. A dialog box appears for you to confirm that you want to clear the prominent tone table.

Prominent Tone Analysis

Figure 6-5 illustrates Sound Power Plus with the Tone Analysis data window active.

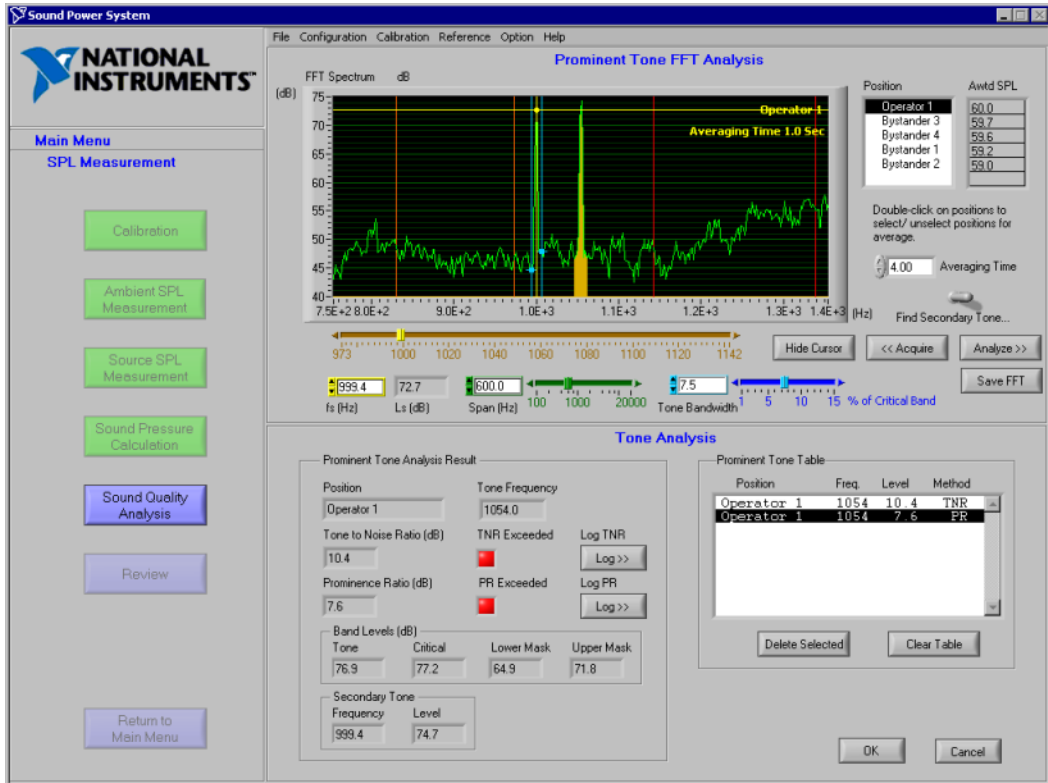


Figure 6-5. Tone Analysis Data Window

Use this window to conduct prominent tone analysis on configured and measured operator/bystander positions. You can access this window by selecting **Main Menu»Sound Pressure Level Measurement»Sound Quality Analysis** in the flowchart window, then selecting the **Go to FFT Analysis to determine presence of Prominent Tone** check box.

The prominent tone analysis routine uses an FFT graphic display window with controls for selecting the microphone for analysis, zooming the FFT display, and controlling the prominent tone analysis bandwidth. The prominent tone analysis data window shows the status of the current tone under analysis and includes controls for logging the tones to a tone table.

The prominent tone analysis routine acquires a time waveform sample of the sound pressure level of the selected microphone and then conducts a post-processing 12,800-line FFT analysis on the sample. This lets you view the FFT over the entire frequency range without having to acquire new samples.

Sound Power Plus conducts prominent tone analysis in accordance with the procedures outlined in ISO 7779 (1999), Annex D (Tone to Noise Ratio) and ANSI S1.13 (1995), Annex A (Tone to Noise and Prominence Ratio Method). Sound Power Plus can conduct analysis on up to two tones within a single critical band.

FFT Display and Cursors

The FFT display provides a graphical display for the 12,800-line FFT. A series of cursors are provided to select tones for analysis, bracket the tone, and indicate the critical and masking bands that surround the tone.

Tone Cursor—Use the **Tone Cursor** to select the center frequency of the primary or secondary tone you are analyzing. You can move the cursor by clicking the yellow cursor controls located below the FFT display. Click and drag the slider for course adjustment, and use the left and right arrows at the end of the control for fine adjustment.

Tone Bandwidth Cursors—Two blue cursors indicate the bandwidth of the energy contained in the selected tone for tone-to-noise ratio analysis. You can control these with the **% of critical bandwidth** slider bar located below the FFT display. When the **Tone Selector** control is in the **Find Secondary Tone** position, the primary tone bandwidth is highlighted in orange, and these blue cursors bracket the secondary tone. ISO 7779 (1999), Annex D.5 requires that the maximum bandwidth of the primary tone not exceed 15% of the critical band centered around the tone center frequency. The blue **Tone Bandwidth** slider control is also limited to this 15% value. If you want to select a primary tone bandwidth that exceeds 15% of critical bandwidth, enter the percent of critical bandwidth desired into the input box of **Tone Bandwidth** control.

Critical Band Cursors—Two red cursors indicate the upper and lower band edges of the critical band centered on the tone frequency. These cursors cannot be controlled and are re-located when the analysis control is activated.

Masking Band Cursors—Two red cursors indicate the band edges of the masking energy used in the prominence ratio analysis. The masking bands extend from these cursor locations to the critical band cursor locations.

ft (Hz)—Indicates the frequency of the current cursor location or the center frequency of the tone when you click **Analysis**.

Lt (dB)—Indicates the level (in decibels) at frequency f_t of the current cursor location.

FFT Window Prominent Tone Analysis Controls

The FFT window contains a series of controls that facilitate prominent tone analysis. These controls let you configure an FFT measurement and select tones for analysis.

The program also supports averaging several microphones for prominent tone analysis. Double-click the positions to be included in the average prior to clicking **Acquire**.

Position—Select operator/bystander sound pressure level positions by clicking on the position. ISO 7779 recommends the prominent tone analysis be conducted at the operator position or the bystander position with the highest AwtD sound pressure level. In support of this recommendation, the positions will be listed in the following order:

1. Operator 1 (if configured)
2. Highest AwtD SPL Bystander Position (if configured)
3. 2nd Highest AwtD SPL Bystander Position (if configured)
4. 3rd Highest AwtD SPL Bystander Position (if configured)
5. 4th Highest AwtD SPL Bystander Position (if configured)
6. Operator 2 (if configured)

Averaging Time—This control lets you select the length of time (in seconds) the sound pressure level at the selected microphone will be sampled. An average FFT of this time sample signal will be performed.

Tone Selector—This switch lets you select whether the **Tone Cursor** and **Tone Bandwidth Cursors** are active for the selection of a primary or secondary tone. When **Tone Selector** is set to **Find Primary Tone**, use the cursors to select and bracket the primary tone you are analyzing. The critical bandwidth surrounding the tone indicated with red cursors move as the center frequency of the primary tone changes. When the **Tone Selector** switch is set to **Find Secondary Tone**, Sound Power Plus freezes the critical bands surrounding the tone and the window zooming Span. The primary tone is highlighted in orange, and the **Tone Cursors** and **Tone Bandwidth Cursors** are activated for selection and bracketing of a secondary tone within the critical band that is centered on the primary tone.

Acquire—Click this button to initiate the acquisition of a sample of the selected microphone for the time selected by the **Averaging Time** control. An average FFT is performed on the sample and displayed on the FFT display.

Center Frequency (Ft/Fs)—This control lets you select the center frequency of primary or secondary tone. When the **Tone Selector** switch is set to **Find Primary Tone**, use the control labeled **ft** to select the center frequency of a primary tone. The acceptable range for this control is 0 to 16000 Hz. When the **Tone Selector** switch is set to **Find Secondary Tone**, use the control labeled **fs** to select the center frequency of the secondary tone. In this position, the acceptable range for this control is limited to upper and lower frequency of the critical band that contains the selected primary tone.

Level of Tone (Lt/Ls)—This indicator displays the energy level in the primary or secondary tone bandwidth. When the **Tone Selector** switch is set to **Find Primary Tone**, this indicator displays **Lt**, which is the energy contained in the selected bandwidth for the primary tone. When the **Tone Selector** switch is set to **Find Secondary Tone**, this indicator displays **Ls**, which is the energy contained within the selected bandwidth for the secondary tone.

Span (Hz)—Click this button to focus around the current cursor location and zoom into a selected frequency range. Use **Span** to select the frequency range (in Hz) indicated on the FFT display.

Tone Bandwidth—This control manages the bandwidth of the energy that will be included in the tone level during tone-to-noise ratio analysis. The blue cursors display the selected bandwidth, and the **Tone Bandwidth** indicator displays this bandwidth in terms of the percentage of the critical bandwidth for the critical band that is centered at the selected tone center frequency. Use the blue slider control to adjust the bandwidth between the minimum 1% and maximum 15% of critical bandwidth. Use the blue numerical bandwidth control to input a value greater than 15% but less than 100% of the critical bandwidth if you want to override the limitations specified in ISO 7779.

Hide Cursors—Click this button to temporarily hide the prominent tone analysis cursors. This lets you view the FFT spectrum without interference from the cursors.

Analyze—Activate this control to conduct an analysis on the selected tone. Both tone-to-noise ratio and prominence ratio calculations will be performed simultaneously. Tone-to-noise ratio calculations are based on

the tone bandwidth that has been bracketed with the **Tone Bandwidth** controls. The results of the analysis are displayed in the Prominent Tone Analysis Results section of the data window.



Note Tone-to-noise ratio analysis uses only the primary tone if **Tone Selector** is set to **Find Primary Tone**. If **Tone Selector** is set to **Find Secondary Tone**, the tone-to-noise ratio analysis includes the primary and secondary tones as defined with the **Tone Cursor** and **Tone Bandwidth** controls.

Save FFT—Click this button to save the current FFT measurement to a file.

Prominent Tone Analysis Results

The data window contains a series of indicators for displaying the results of the prominent tone analysis and a series of controls for logging tones to a prominent tone results table. The contents of the prominent tone results table are shown on the right side of the data window.

Position—The position under analysis

Tone Frequency—The center frequency of the primary tone in Hz

Tone to Noise Ratio (dB)—The calculated tone-to-noise ratio

Prominence Ratio (dB)—The calculated prominence ratio

Exceeded—Each tone analysis method (Tone-to-Noise Ratio/Prominence Ratio) has an **Exceeded** indicator. This indicator lights red if the analysis result exceeds the criteria level selected in sound quality analysis options.

Log—Each tone analysis method (Tone-to-Noise Ratio/Prominence Ratio) has a button that allows the analysis results to be logged to the prominent tone table. Click this button to write the results of the selected analysis method to the prominent tone table.

Band Levels (dB)—This table provides information about the levels in each of the bands used for prominent tone analysis.

- **Tone**—Level in bandwidth bracketed by tone bandwidth cursors for tone-to-noise ratio analysis.
- **Critical**—Level in the critical band surrounding the selected tone, exclusive of the energy bracketed by the tone bandwidth cursors.

- **Lower Mask**—Level in the lower masking band for prominence ratio analysis.
- **Upper Mask**—Level in the upper masking band for prominence ratio analysis.

Secondary Tone—This table displays the information of the secondary tone when you select that option during prominent tone analysis.

- **Frequency**—This indicator displays the center frequency of the secondary tone in Hz.
- **Level (dB)**—This indicator displays the sound pressure level within the secondary tone bandwidth.

Prominent Tone Table

To the right of the prominent tone analysis data window is the prominent tone table, where the logged results are displayed.

Delete Selected—Lets you highlight a logged tone and delete it.

Clear Table—Lets you delete all logged tones.

OK—Click this button to accept the values and return to the main SPL Measurement flowchart.

Cancel—Click this button to ignore your changes and return to the main SPL Measurement flowchart.



Note Use the **Save FFT** feature included in the prominent tone analysis routine to save the high resolution FFT results to a file. If you are using the demo version of Sound Power Plus, you can view these results files by renaming them to `Operator1.txt` and moving them to the `Sound Power Plus Demo/Bin` directory. This feature allows you to re-analyze FFT spectra from prominent tones at a later date. Contact National Instruments for more information on the Sound Power Plus demo version.

Review

Figure 6-6 illustrates Sound Power Plus with the Sound Pressure Level Report data window active.

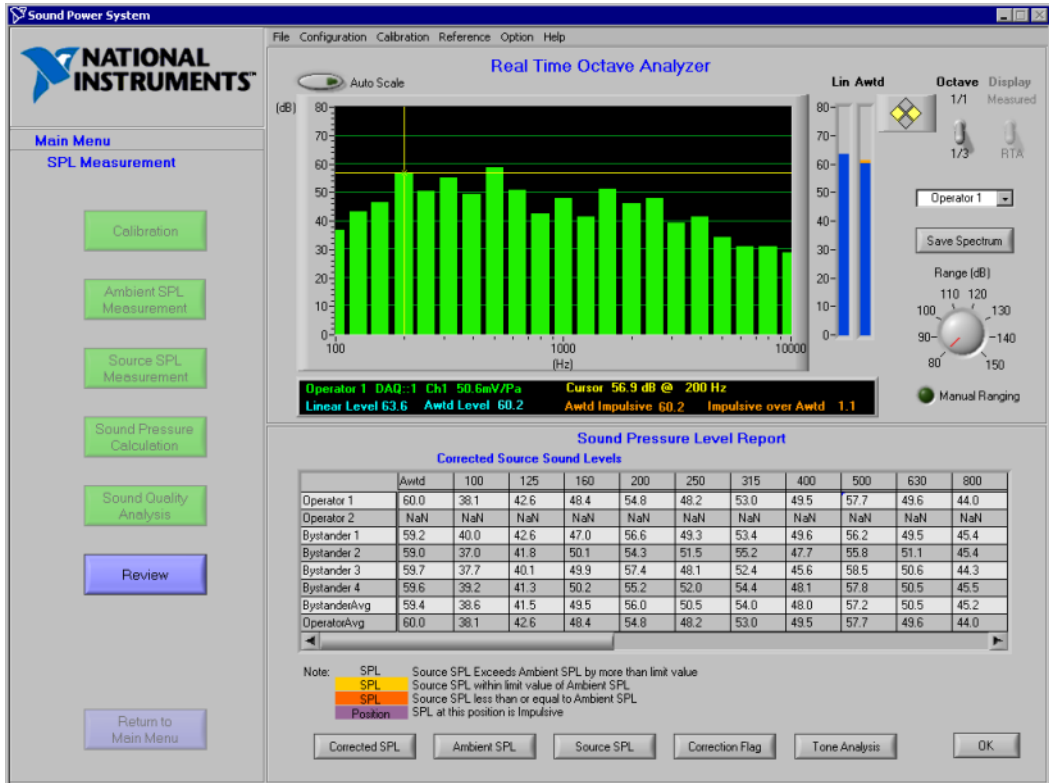


Figure 6-6. Sound Pressure Level Report Data Window

Use this window to display the results of the sound pressure level measurement and calculations. You can access this window by selecting **Main Menu»Sound Pressure Level Measurement** in the flowchart window, then clicking on the **Review** button.

Click the buttons at the bottom of the window to access the details of the sound power calculation. For more information about how the calculations are made, refer to Appendix A, *Configuration Concepts, Protocols, and Calculations*.

The results are displayed in the data table. For convenience, the A-weighted value is displayed in the leftmost column.

The results are displayed in a graphical form in the graphic window. If you entered reference spectrum, it can be displayed on the same graph.

Corrected SPL—Click this button to display the corrected source sound pressure levels at each position and the surface average corrected source sound pressure level. Ambient correction flags are displayed as colored indicators on the corrected sound pressure level data in accordance with the legend on the screen.

Ambient SPL—Click this button to display the ambient sound pressure levels at each measurement position and the surface average ambient SPL.

Source SPL—Click this button to display the source sound pressure levels at each measurement position and the surface average source SPL.

Correction Flag—Click this button to display the ambient status flags for each position, the surface average, and any additional position status. Ambient correction flags in this view are expressed in terms of a condition code as described in the legend. These conditions codes are included with the exported data.

Tone Analysis—Click this button to display the prominent tone test results.

OK—Click this button to return to the Sound Pressure main menu.

Exporting Data

Sound Power Plus allows you to export data into text files or pre-formatted Microsoft Excel workbook template files. Figure 7-1 illustrates the Data Export window.

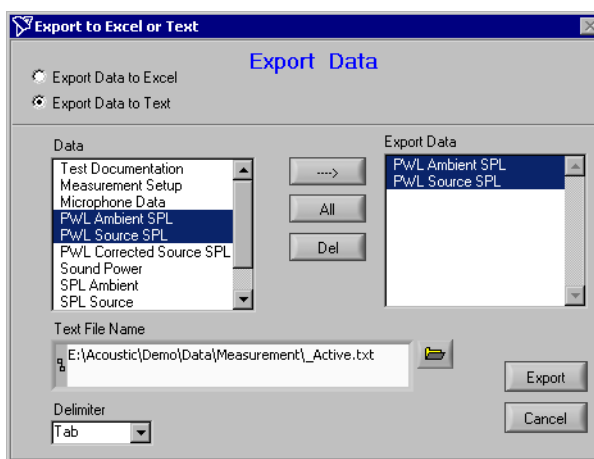


Figure 7-1. Data Export Window

- **Export Data to Excel**—Click this button to export data to Microsoft Excel 97 or its higher version.
- **Export Data to Text**—Click this button to export data to text file.



Tip You can also access this window by selecting **Main Menu»Export Data** in the flow chart window.

Save to Excel File

Selecting **Export to Excel** disables the option controls for **Export Data to Text**. Clicking **Export** brings up another dialog window for exporting data into pre-formatted Microsoft Excel workbook template files. These workbook template files contain a series of worksheets for each section of the test information. You can also add additional worksheets to your template workbook files. You can preconfigure and pre-link these

additional worksheets to your export worksheets, providing an efficient method for setting up custom data analysis templates. See Appendix B, *Program and Data Files*, for more information on the structure of workbook template files.



Note The **Export to Excel** feature of Sound Power Plus exports all SPL and SPL test documentation and test data associated with the test into the first 11 worksheets of an Excel workbook. To export partial data from the project, use the **Export Data** feature on the Sound Power, Source Sound Pressure Level measurement window (see the *Exporting Data* section in Chapter 5, *Sound Power Level Measurement*) or the **Export to Text** feature.

When you click the **Export Data** button, a file dialog box prompts you to choose a template file as the export destination. You can select any Excel workbook that is structured as described in Appendix B, *Program and Data Files*.



Note Sound Power Plus includes an example workbook template file called `Report Template.xls`. This workbook template file contains all necessary worksheets for Sound Power Plus export data and contains several user worksheets that create certificate-like test reports for sound power and sound pressure measurement data. You can use this workbook template file to create other custom template files.

1. Select a template file for the export and click **Open**.

A file dialog box prompts you to enter or confirm a default file name for the exported data file. By default, the routine suggests a file name of `Test Name_Operating Mode`, where `Test Name` and `Operating Mode` are derived from the test documentation. Learn more about configuring your test documentation in Chapter 3, *Documenting Your Test*, for information on configuring your test documentation. You can accept this name or enter a new file name.

2. Click **Save** to Export.

A dialog box informs you of the progress of the export progress. A check box option lets you leave Excel open after the data is exported.

Save to Text file

The **Save to Text** file allows you to select any or all of the test documentation or test data for export. When you choose this option, the controls for **Save to Text** are enabled. Select the items you want to export by highlighting them on the left side of the dialog box, and move them into the export list on the right side of the dialog box by pressing the <arrow> control. You can select all documentation and data using the **All** control. Remove items from the export list by highlighting them and pressing **Del**.

Data—This control contains all data items that can be exported.

Select—Press the arrow key to place the selected items in **Data** control into the **Export Data** list.

All—Click this button to select all data items and add them to the **Export Data** list.

Del—Press **Del** to deselect a data item. You can only deselect one data item at a time.

Export Data—Contains a list of all data items selected for export.

Text File Name—This file dialog control contains the name of the text file you have selected as your destination. You can specify a new file name or locate an existing file with the **Browse** function. The default file name is `Test Number_Operating Mode.txt` and the default file path is `the/Data/Measurement` directory.

Delimiter—Use this control to specify a delimiter for the exported file. <Tab> is the default delimiter and works well for text data that you are exporting into spreadsheet or database files. You may also select **Other** in the **Delimiter** control to activate the Other control, allowing you to specify a custom delimiter.

Other—This option appears only when you select **Other** in the **Delimiter** list box. This control allows you to use any character as a delimiter in an exported-text file.



Note Be sure to choose delimiter character(s) that do *not* appear in any of the data fields you are exporting.

Export—Click **Export** to export the data contained in the **Export Data** window. If the saved file already exists, Sound Power Plus prompts you for approval before executing the export. If you click **OK**, the data in the existing file will be replaced. When the data export is complete, the **Export** data window is closed.

Cancel—Click **Cancel** to cancel the export process without exporting any data.

Configure the Reference Spectrum

The reference spectrum feature allows the following types of spectra to be held in the system for comparison with measurement results:

- **Sound Power Level**—A sound power reference spectrum that is displayed in the graphic window with the current sound power measurement result.
- **SPL for Sound Power Level**—A sound pressure level spectrum that is displayed in the graphic window with the sound pressure level measurements made during a sound power level measurement.
- **SPL at Operator Position**—A sound pressure level spectrum that is displayed in the graphic window with the sound pressure level measurements made during the operator/bystander sound pressure level measurement.
- **Free Running SPL**—A reference spectrum that is displayed in the graphic window when the RTA is in free-running mode.
- **Source FFT**—An FFT spectrum that is displayed in the graphic window during the source sound pressure level FFT measurement.

Reference spectra are displayed on the graphic window along with the current measurement or results spectrum. 1/3-octave reference spectra are displayed as a series of yellow dots, and reference FFT spectra are displayed as dark green lines.

Enter reference spectra the system using the following methods:

- The sound power level, operator/bystander sound pressure level graphic results, and RTA windows have controls that let you store the current spectrum as a reference spectrum.
- Reference spectra can be saved to a named file and loaded into the reference spectrum using the main menu bar.

Follow these steps to place a spectrum from one of the measured positions into the Reference Spectrum:

1. Select the position you want to include in the Reference Spectrum by clicking the check box for that position.
2. Move the switch on the RTA to the **Measured** position.
3. Click the **Save Spectrum** button on the RTA.

Reference spectra are constantly displayed in the graphic window. To turn off a reference spectrum, select **Reference»Edit Spectrum**, then click the **Clear** button in the Reference Spectrum Edit for Instrument Configuration data window to change all frequency bands to NaN (Not a Number).

Reference Spectrum Configuration

You can either load reference spectrum information into Sound Power Plus from a file, or enter new reference spectrum data. To load a spectrum into the selected reference, select **Reference»Load Spectrum**. A dialog box prompts you to enter the name of the file you want to load. The spectrum files must be in Sound Power Plus native file format.

To load the default reference spectrum data, select **Reference»Load Spectrum»Default**, then select a reference spectrum (Sound Power Level, SPL for Sound Power Level, SPL at Operator Position, Free Running SPL, or Source FFT). Select **Reference»Load Spectrum»Default»All** if you want to load the default files for all reference spectra.

To enter or clear the reference spectrum data, select **Reference»Edit Spectrum**.

Figure 8-1 illustrates Sound Power Plus with the Reference Spectrum Edit for Instrument Configuration data window active.

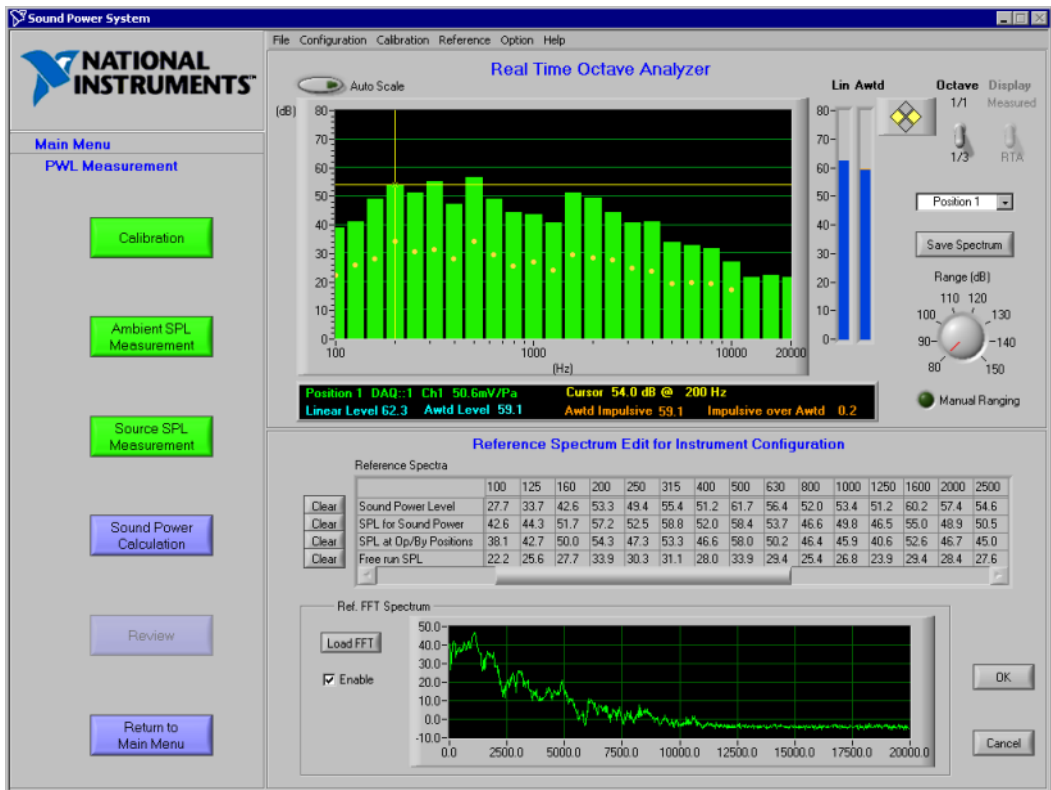


Figure 8-1. Reference Spectrum Edit for Instrument Configuration Data Window

Use this window to edit or clear the sound power and sound pressure reference spectra supported by the software. You can also use this window to view, load, and enable the FFT reference spectrum. You can access this window by selecting **Reference»Edit Spectrum** from the main menu.

Reference Spectra Table—Lists the current values for the sound power and sound pressure level reference spectra supported by the software. You can edit values in this table by selecting the cell and entering a new value.

Clear—Clears the values in this reference spectrum. When you click this button, all cells are set to NaN (Not a Number) and no reference spectrum is displayed.

Load FFT—Click this button to load an FFT spectrum from a saved file. A prompt appears asking you to choose the file.

Enable—Select this check box to enable the FFT reference spectrum.



Note The FFT reference spectrum cannot be manually edited.

OK—Click this button to accept the values you entered and exit the reference spectrum configuration.

Cancel—Click this button to cancel all entries and exit the reference spectrum configuration.

Configuration Concepts, Protocols, and Calculations

Instrument and Measurement Configuration Concepts

Sound Power Plus instrument and measurement configuration routines are based on the concepts explained in the following sections.

Instrument Configuration

During instrument configuration, you set up your DAQ boards with one or more measurement channels each. Sound Power Plus supports the NI 4551 and NI 4552 boards.

Each DAQ channel can have a multiplexer with multiple microphone inputs. Several common microphone multiplexers are currently supported as listed in Appendix C, *Supported Drivers*.

During instrument configuration, you can configure the number of microphones on the instrumentation system.

Measurement Configuration

During the measurement configuration, you define a number of measurement positions, then assign one of the configured microphones to each position. Using this concept, the number of measurement positions is independent of the number of microphones available on the measurement system.

Table A-1 illustrates an example of how microphones might be assigned.

Table A-1. Microphone Assignment Logic

Position Number	Microphone Number	Multiplexer Number	Multiplexer Channel Number	Board Number	Board Channel Number
Position 1	Microphone 1	Mux 1	Mux Channel 1	Board 1	Channel 1
Position 2	Microphone 2	Mux 1	Mux Channel 2	Board 1	Channel 1
...
Position 10	Microphone 10	Mux 1	Mux Channel 10	Board 1	Channel 1
Position 11	Microphone 11	Mux 2	Mux Channel 1	Board 1	Channel 2
Position 12	Microphone 12	Mux 2	Mux Channel 2	Board 1	Channel 2
...
Position 19	Microphone 19	Mux 2	Mux Channel 9	Board 1	Channel 2
Position 20	Microphone 20	Mux 2	Mux Channel 10	Board 1	Channel 2

Figure A-1 illustrates an example system.

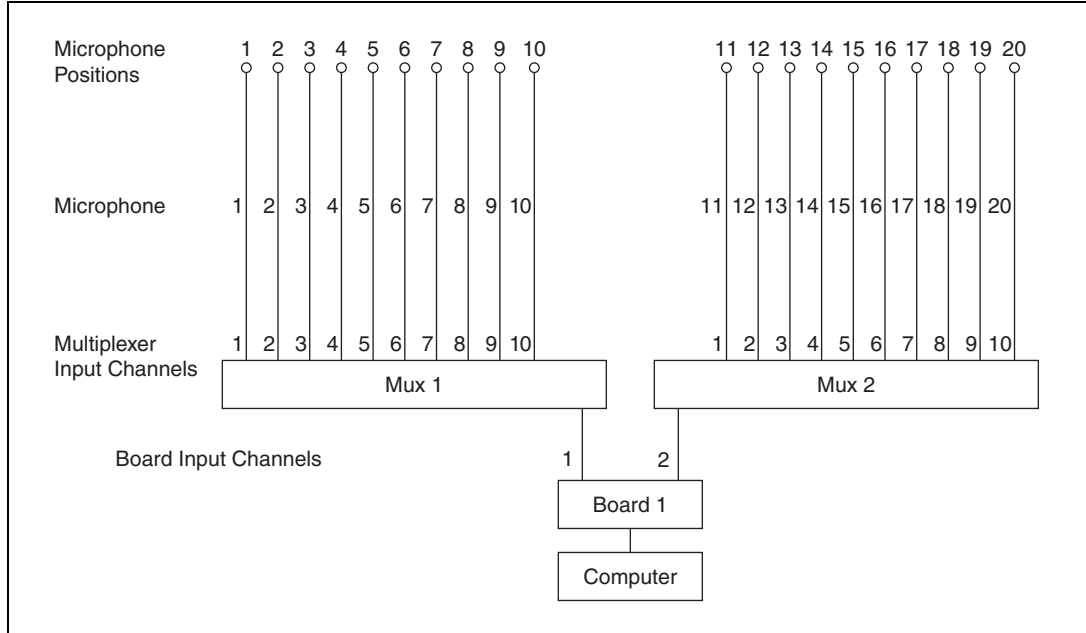


Figure A-1. Example System

A single microphone can be assigned to one or more measurement positions. This allows multi-position sound power measurements to be made with instrumentation systems containing fewer microphones than measurement positions. For example, you could use one microphone to make a 10-position sound power measurement. Or, you could use a ten-microphone grid to make a 20-position sound power measurement. The **Paused/Proceed** option on the Measurement Setup menu and **Measure Selected Position(s)** option on the sound pressure level measurement menus facilitate the use of this functionality.

The software supports frequency response corrections for each measurement channel (microphone). These frequency response corrections are associated with each microphone measurement channel that has been configured for the system.

Sound Power Ambient Correction Calculation Logic

The following tables describe the steps and calculations Sound Power Plus uses to calculate the ambient correction.

Position-by-Position Corrections

Table A-2 describes how ambient corrections are applied on a position-by-position basis, as described in ISO 7779-1988, section 6.7.3.

Table A-2. Position-by-Position Ambient Corrections

Action	Calculations
Correct source SPL at each position using ambient SPL at each position	<p>Case: $SourceSPL(f,n) - AmbientSPL(f,n) \geq Correction\ Limit$</p> $CorrectedSPL(f,n) = 10 * \log (10^{SourceSPL(f,n)/10} - 10^{AmbientSPL(f,n)/10})$ <p>Case: $SourceSPL(f,n) - Ambient\ SPL(f,n) < Correction\ Limit$</p> <p>If Correct Below Limit = True</p> $CorrectedSPL(f,n) = SPL(f,n) + 10 * \log (1 - 10^{-CorrectLimit/10})$ <p>If No Data Below Limit = True</p> $CorrectedSPL(f,n) = 0$ <p>If Correct Below Limit = False AND No Data Below Limit = False</p> $CorrectedSPL(f,n) = SourceSPL(f,n)$
Set ambient status flags for each position	<p>Case: $SourceSPL(f,n) - AmbientSPL(f,n) \geq Correction\ Limit$</p> $AmbientStatusFlag(f,n) = 0$ <p>Case: $Correction\ Limit > SourceSPL(f,n) - AmbientSPL(f,n) > 0$</p> $AmbientStatusFlag(f,n) = 1$ <p>Case: $SourceSPL(f,n) - AmbientSPL(f,n) \leq 0$</p> $AmbientStatusFlag(f,n) = 2$
Surface average source, ambient, and corrected source sound pressure levels	$SurfaceAvgSPL(f) = 10 * \log (1 / TotSurfaceArea * \sum_{i=1}^{i=n} SurfaceArea(n) * 10^{SPL(f,n) / 10})$ <p>Do this calculation for SourceSPL, AmbientSPL, and CorrectedSourceSPL for all frequency bands.</p>

Table A-2. Position-by-Position Ambient Corrections (Continued)

Action	Calculations						
Set surface average ambient status flags	<p>Case: SurfaceAvgSourceSPL(f) – SurfaceAvgAmbientSPL(f) ≥ Correction Limit</p> $\text{SurfaceAvgAmbientStatusFlag}(f) = 0$ <p>Case: Correction Limit > SurfaceAvgSourceSPL(f) – SurfaceAvgAmbientSPL(f) < 0</p> $\text{SurfaceAvgAmbientStatusFlag}(f) = 1$ <p>Case: SurfaceAvgSource(f) – SurfaceAvgAmbient(f) ≤ 0</p> $\text{SurfaceAvgAmbientStatusFlag}(f) = 2$						
Calculate sound power	<p>Case: Apply Meteorological Correction = True</p> $\text{SoundPower}(f) = \text{SurfaceAvgCorrectedSoundPressure}(f) + 10 * \log(\text{TotSurfaceArea}) - 10 * \log[(314.15 / (1013.25 + \text{Temperature}))^{0.5} * (\text{BarometricPressure} / 1013.25)]$ <p>Case: Apply Meteorological Correction = False</p> $\text{SoundPower}(f) = \text{SurfaceAvgCorrectedSoundPressure}(f) + 10 * \log(\text{TotalSurfaceArea})$						
<p>Where</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none;">n = measurement position</td> <td style="width: 50%; border: none;">Barometric Pressure in millibars</td> </tr> <tr> <td style="border: none;">f = 1/3-octave band center frequency</td> <td style="border: none;">Temperature in °C</td> </tr> <tr> <td style="border: none;">Total Surface Area in square meters</td> <td style="border: none;"></td> </tr> </table>		n = measurement position	Barometric Pressure in millibars	f = 1/3-octave band center frequency	Temperature in °C	Total Surface Area in square meters	
n = measurement position	Barometric Pressure in millibars						
f = 1/3-octave band center frequency	Temperature in °C						
Total Surface Area in square meters							

Surface Average Corrections

Table A-3 describes how ambient corrections are applied based on surface average, as described in ISO 3744-1994, section 8.3.

Table A-3. Surface Average Ambient Corrections

Action	Calculations
Set ambient status flags for each position	<p>Case: $SourceSPL(f,n) - AmbientSPL(f,n) \geq Correction\ Limit$</p> $AmbientStatusFlag(f,n) = 0$ <p>Case: $Correction\ Limit > SourceSPL(f,n) - AmbientSPL(f,n) > 0$</p> $AmbientStatusFlag(f,n) = 1$ <p>Case: $SourceSPL(f,n) - AmbientSPL(f,n) \leq 0$</p> $AmbientStatusFlag(f,n) = 2$
Surface average source and ambient sound pressure levels	$SurfaceAvgSPL(f) = 10 * \log (1 / TotSurfaceArea * \sum_{i=1}^{i=n} SurfaceArea(n) * 10^{SPL(f,n) / 10})$ <p>Do this calculation for SourceSPL and AmbientSPL for all frequency bands.</p>
Correct surface average source sound pressure level using surface ambient sound pressure level	<p>Case: $SurfaceAvgSourceSPL(f) - SurfaceAvgAmbientSPL(f) \geq Correction\ Limit$</p> $CorrectedSurfaceAvgSourceSPL(f) - 10 * \log (10^{SurfaceAvgSourceSPL(f)/10} - 10^{SurfaceAvgAmbientSPL(f)/10})$ <p>Case: $SurfaceAvgSourceSPL(f) - SurfaceAvgAmbientSPL(f) < Correction\ Limit$</p> <p>If Correct Below Limit = True</p> $CorrectedSurfaceAvgSourceSPL(f) = SurfaceAvgSourceSPL(f) + 10 \log (1 - 10^{-(CorrectionLimit/10)})$ <p>If No Data Below Limit = True</p> $CorrectedSurfaceAvgSPL(f) = 0$ <p>If Correct Below Limit = False AND No Data Below Limit = False</p> $CorrectedSurfaceAvgSPL(f) = SurfaceAvgSourceSPL(f)$

Table A-3. Surface Average Ambient Corrections (Continued)

Action	Calculations						
Set surface average ambient status flags	<p>Case: SurfaceAvgSourceSPL(f) – SurfaceAvgAmbientSPL(f) ≥ Correction Limit</p> $\text{SurfaceAvgAmbientStatusFlag}(f) = 0$ <p>Case: Correction Limit > SurfaceAvgSourceSPL(f) – SurfaceAvgAmbientSPL(f) < 0</p> $\text{SurfaceAvgAmbientStatusFlag}(f) = 1$ <p>Case: SurfaceAvgSource(f)-SurfaceAvgAmbient(f) ≤ 0</p> $\text{SurfaceAvgAmbientStatusFlag}(f) = 2$						
Calculate sound power	<p>Case: Apply Meteorological Correction = True</p> $\text{SoundPower}(f) = \text{SurfaceAvgCorrectedSoundPressure}(f) + 10 * \log(\text{TotSurfaceArea}) - 10 * \log[(314.15 / (273.15 + \text{Temperature}))^{0.5} * (\text{BarometricPressure} / 1013.25)]$ <p>Case: Apply Meteorological Correction = False</p> $\text{SoundPower}(f) = \text{SurfaceAvgCorrectedSoundPressure}(f) + 10 * \log(\text{TotalSurfaceArea})$						
<p>Where</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none;"><i>n</i> = measurement position</td> <td style="width: 50%; border: none;">Barometric Pressure in millibars</td> </tr> <tr> <td style="border: none;"><i>f</i> = 1/3-octave band center frequency</td> <td style="border: none;">Temperature in °C</td> </tr> <tr> <td style="border: none;">Total Surface Area in square meters</td> <td style="border: none;"></td> </tr> </table>		<i>n</i> = measurement position	Barometric Pressure in millibars	<i>f</i> = 1/3-octave band center frequency	Temperature in °C	Total Surface Area in square meters	
<i>n</i> = measurement position	Barometric Pressure in millibars						
<i>f</i> = 1/3-octave band center frequency	Temperature in °C						
Total Surface Area in square meters							

Sound Quality Analysis Calculations

Sound Power Plus implements the following two sound quality analysis routines:

- **Impulsive Noise Analysis**—An impulsive noise analysis routine that follows the procedures defined in ISO 7779, Annex E, is integrated into the operator/bystander source sound pressure level measurement routine, providing “on-the-fly” impulsiveness analysis of sound pressure at each position. This routine utilizes the ability of the instrument to calculate both L_A and L_{AI} simultaneously. Indicators on the source sound pressure level data window indicate when L_{AI} exceeds L_A by an amount defined in the sound quality analysis options for impulsive noise criteria level. The state of the impulsive noise indicator for each position is stored in the program data file and is exported to Excel for use in reporting.
- **Prominent Tone Analysis**—Sound Power Plus supports prominent tone analysis by two methods:
 - **Tone to Noise Ratio**—As defined in ISO 7779, Annex D.
 - **Prominence Ratio Analysis**—As referenced in ISO 7779, Annex D, and ANSI S1.13. See *A Procedure for Determining the Prominence Ratio of Discrete Tones in Noise Emissions* by Nobile and Bienvenue for detailed information on the logic employed by the prominence ratio routine.

A prominent tone listening test provides for documentation of listening and/or FFT analysis activities conducted to determine the presence of prominent discrete tones. Prominent tones are detected when the tone band energy exceeds the masking band energy by a criteria level that is established in the Sound Quality Analysis in the sound pressure level measurement configuration. Prominent tones detected by either or both methods may be logged to a prominent tone table which is stored with the test data file and exported into Excel for use in reporting.

Prominent Tone Logic and Calculations

Figure A-2 and Table A-4 describe the calculations performed at each step in the prominent tone analysis routine.

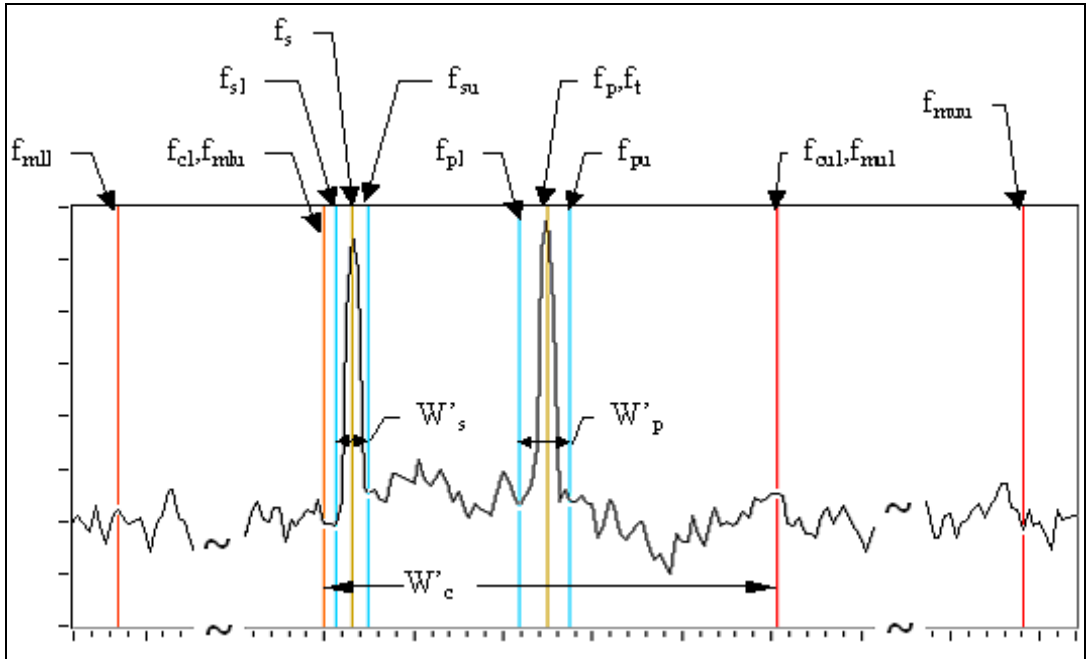


Figure A-2. Prominent Tone Analysis Logic

Table A-4. Prominent Tone Logic and Calculations

Action	Calculations
Bracket possible tone (Tone bandwidth control)	Tone Cursor Position = $f_p = f_t$; primary tone center frequency Upper Cursor Position = f_{pu} ; primary tone upper frequency limit Lower Cursor Position = f_{pl} ; primary tone lower frequency limit Primary tone bandwidth = $\Delta f_p = f_{pu} - f_{pl}$
Calculate critical and masking bands for possible tone under analysis	$\Delta f_c = 25 + 75 * (1 + 1.4(f_t/1000)^2)^{0.69}$; critical bandwidth $f_{cl} = -\Delta f_c / 2 + \text{sqrt}(\Delta f_c^2 + 4 * f_t^2) / 2$; critical band lower freq limit $f_{cu} = f_{cl} + \Delta f_c$ critical band upper freq limit $f_{mll} = f_{cl}^2 / f_{cu}$ masking noise, low band, lower freq limit $f_{mlu} = f_{cl}$ masking noise, low band, upper freq limit $f_{mul} = f_{cu}$ masking noise, upper band, low freq limit $f_{muu} = f_{cu}^2 / f_{cl}$ masking noise, upper band, upper freq limit
Bracket possible secondary tone (optional)	Tone Cursor Position = f_s ; secondary tone center frequency Upper Cursor Position = f_{su} ; secondary tone upper frequency limit Lower Cursor Position = f_{sl} ; secondary tone lower frequency limit Secondary tone bandwidth = $\Delta f_s = f_{su} - f_{sl}$
Calculate energy in tone and critical bands	W'_p = Energy sum between f_{pu} and f_{pl} W'_s = Energy sum between f_{su} and f_{sl} W_c = Energy sum between f_{cl} and f_{cu} W_{ml} = Energy sum between f_{mll} and f_{mlu} W_{mu} = Energy sum between f_{mul} and f_{muu} $W_i = \Sigma 10^{(SPL_i/10)}$
Calculate Prominence Ratio	$PR = 10_{\log}(W_c / ((W_{ml} + W_{mu}) / 2))$
Calculate Energy of Tones and Noise	<p>Case 1: No secondary tone allocated</p> $W_n = (W_c - W'_p) * [\Delta f_c / (\Delta f_c - \Delta f_p)]$ $W_t = W'_p - W'_n * \Delta f_p / \Delta f_c$ <p>Case 2: Secondary tone allocated</p> $W_n = (W_c - W'_p - W'_s) * [\Delta f_c / (\Delta f_c - \Delta f_p - \Delta f_s)]$ $f_d = 21 * 10^{[1.2 \log(f_t/212) ^{1.8}]}$ <p>If $[f_p - f_s] \leq f_d$</p> $W_t = W'_p + W'_s - W_n * (\Delta f_p + \Delta f_s) / \Delta f_c$ <p>If $[f_p - f_s] > f_d$</p> $W_t = W'_p - W'_n * \Delta f_p / \Delta f_c$

Table A-4. Prominent Tone Logic and Calculations (Continued)

Action	Calculations
Calculate Tone to Noise Ratio	$TNR = 10 \log (W_t / W_n)$
Test tone ratios against criteria levels	Set Tone-to-Noise and/or Prominence Ratio indicators

Operator/Bystander Calculations

Operator/bystander ambient noise corrections follow the same general logic as described for sound power ambient noise corrections. The following logic is unique to the sound pressure routine:

- Ambient corrections are applied on a position-by-position basis for each individual position.
- There is no **No Data if below Limit** option.

Ambient status flags are applied as described in the sound power routine.

Operator Average Sound Pressure Level Calculation

If Operator 1 and Operator 2 positions are active, the program calculates an operator average sound pressure level by energy averaging the Operator 1 and Operator 2 sound pressure level data. If only Operator 1 or Operator 2 positions are active, the operator average sound pressure level will equal the active operator position sound pressure level.

Operator average ambient status flags are set by comparing the average operator source and ambient sound pressure levels.

Bystander Average Sound Pressure Level Calculation

The software calculates a bystander average sound pressure level for all bystander positions by energy averaging the sound pressure level data for all bystander positions that are active.

Bystander average ambient status flags are set by comparing the average bystander source and ambient source pressure levels. If only one bystander position is active, the bystander average source pressure level equals the corrected source pressure level for the selected bystander position. If no bystander position is active, no bystander average source pressure level is calculated.

Sound Pressure Level Measurement Precision and Rounding Issues

All sound pressure level measurements made by the board are rounded to the nearest 0.1 dB before the levels are entered into the program database. All intermediate calculations are double-precision calculations that are conducted on this rounded data, with no intermediate rounding steps.

Program and Data Files

Sound Power Plus creates and uses several types of files, as defined in Table B-1.

Table B-1. File Types Used by Sound Power Plus

Type of File	Extension	Default Location	Default File Name
Measurement	.Mea	Sound Power\Data\ Measurement	test name_ operating mode
Sound Power Data	.PWL	Sound Power\Data\ Measurement	test name_ operating mode
Sound Pressure Data	.SPL	Sound Power\Data\ Measurement	test name_ operating mode
Instrument Configuration	.InC	Sound Power\Data\Config	Global_Instrument Configuration_ Default
PWL Measurement Configuration	.PWC	Sound Power\Data\Config	Global_Sound Power Level_Default
SPL Measurement Configuration	.SPC	Sound Power\Data\Config	Global_Sound Pressure Level_Default
PWL Reference Spectrum	.ReP	Sound Power\Data\Spectra	Ref_Sound Power Level_Default
SPL for PWL Reference Spectrum	.ReL	Sound Power\Data\Spectra	Ref_SPL for Sound Power Level_Default
Operator/Bystander SPL Reference Spectrum	.ReL	Sound Power\Data\Spectra	Ref_SPL at Operator Positions_Default
Free Running SPL Reference Spectrum	.ReL	Sound Power\Data\Spectra	Ref_Sound Pressure Level_Default

Table B-1. File Types Used by Sound Power Plus (Continued)

Type of File	Extension	Default Location	Default File Name
Microphone Sensitivity	.xls	Sound Power\Data\ Microphone	Microphone Sensitivity Template
Data Export	.xls	Sound Power\Data\ Measurement	test name_operating mode
FFT Reference Spectrum	.txt	Sound Power\Data\ Measurement	Ref_FFT_Default
FFT Data	.txt	Sound Power\Data\ Measurement	Not applicable
Excel Export Template	.xls	Sound Power\Data\ Template	Report Template
Multiplexer Data	.xls	Sound Power\Data\Multiplexer Drivers	multiplexer.ini
Text Export Files	.txt	Sound Power\Data\Measurement	Test name_operating mode
Multiplexer Data	.ini	Sound Power\Data\Multiplexer Drivers	multiplexer.ini
Text Information	.ini	Sound Power\Data	Test information.ini

Sound Power Plus test data is stored in three files. One file contains the sound power measurement data. A second file contains the sound pressure level measurement data. The .Mea file is used to link these files into a single test file. When loading or saving data in Sound Power Plus, you reference the .Mea file. When copying data files to another directory or computer, you must copy all three files.

All files other than .xls, .txt, and .ini files are saved in native file format for Sound Power Plus. These files are created or read from within Sound Power Plus. They cannot be edited by a text editor or Microsoft Excel. This file format is used for test data files, instrument and measurement configuration files, and reference spectrum files.

.xls files—Microsoft Excel file format used for data export files and microphone sensitivity files.

- The **Export Data to Excel** function in Sound Power Plus main menu writes, but does not read, .xls files.
- The **Export Data to Excel** function in the Source SPL Measurement menu reads and writes .xls files.
- Sound Power Plus reads, but does not write, microphone sensitivity files saved in the .xls format.

.ini files—Text files containing Sound Power Plus data.

All Sound Power Plus multiplexer information is located in a file named `Sound Power\Data\Multiplexer Drivers\Multiplexers.ini`. This text file includes all of the necessary multiplexer information required for using a multiplexer driver with Sound Power Plus.

You can add your own multiplexer files to `Multiplexers.ini`. Sound Power Plus can incorporate the new multiplexer files into the list of configurable multiplexers available in your system configuration.

Sound Power Plus also dynamically calls the multiplexer driver designated in `Multiplexers.ini` when operating a multiplexer. Refer to Appendix C, *Supported Drivers*, for more information on drivers.

All Sound Power Plus test information options for test documentation is located in a file named `Sound Power\Data\Test Information.ini`. This file includes several source types and operation modes. Sound Power Plus uses this test information when you set up your source information for your test documentation. You can add or remove items from this file if they do not fit your application.

Data Export Files

Sound Power Plus supports the export of test data into Excel workbooks. Data is exported onto a series of worksheets within a workbook template. Data is organized onto worksheets to facilitate review and formula referencing.

Workbook Templates

Sound Power Plus can export all test documentation, measurement, and configuration data into an Excel workbook. The export process is explained in Chapter 7, *Exporting Data*. Data is exported into workbook template

files that you can customize. The standard format for an Excel workbook template is an Excel file with 11 specific worksheets and additional customizable analysis worksheets. The workbook uses the following format:

- **Worksheet 1 (Test Documentation)**—All data from the four **Test Documentation** windows.
- **Worksheet 2 (Measurement Setup)**—All data from the sound power and sound pressure level measurement configuration screens.
- **Worksheet 3 (Microphone Data)**—All data associated with the sensitivity, calibration parameters, and frequency response corrections for the microphones that were configured for this test.
- **Worksheet 4 (PWL Ambient SPL)**—Ambient sound pressure level data obtained during the sound power level measurement routine.
- **Worksheet 5 (PWL Source SPL)**—Source sound pressure level data obtained during the sound power level measurement routine.
- **Worksheet 6 (PWL Corrected Source SPL)**—The corrected sound pressure level data and ambient condition flags calculated during the sound power level measurement routine.
- **Worksheet 7 (Sound Power)**—Sound power levels calculated during the sound power level measurement routine.
- **Worksheet 8 (SPL Ambient)**—Ambient sound pressure level data obtained during the operator/bystander sound pressure level measurement routine.
- **Worksheet 9 (SPL Source)**—Source sound pressure level data obtained during the operator/bystander sound pressure level measurement routine.
- **Worksheet 10 (Operator/Bystander SPL)**—The corrected sound pressure level data and ambient conditions flags calculated during the operator/bystander sound pressure level measurement routine.
- **Worksheet 11 (Prominent Tones)**—Prominent tones recorded to the prominent tone table during sound quality analysis in the operator/bystander sound pressure level routine.
- **Worksheet 12-*n* (User Worksheets)**—You can establish export template files that contain pre-designed analysis worksheets, graphs, and reports. Sound Power Plus lets you designate the name of the template file into which the test data is exported.

The Report Template workbook provided with Sound Power Plus creates three custom worksheets that provide certificate-based reports of sound power and sound pressure test data. Use this workbook as an example to create custom analysis template files of your own.



Note Sound Power Plus exports data into Excel workbooks that are configured consistent with the master template file format. The first 11 worksheets of the Excel template file must be named as shown in the template file. Any custom entries on the first 11 worksheets will be overwritten when the data is exported. User worksheets must be named with names other than those used for the 11 export worksheets. Data on user worksheets is not changed during data export.

Microphone Sensitivity Files

Data on microphone sensitivity, calibration parameters, and frequency response is stored in this Excel worksheet.

Worksheet Contents

You can import microphone parameters into Sound Power Plus from this Excel worksheet. In this worksheet, you can give each microphone a name and serial number. You can also track and document microphone sensitivity, normal calibration offsets, and frequency response. You can view, add, and edit microphone parameters in the `Microphone Sensitivity Template.xls` file.

(Microphone) Name—A common name by which the microphone is referred to in Sound Power Plus (such as Microphone 1, Mic A, and so on).

Serial Number—A serial number (often as assigned by the manufacturer) that uniquely identifies the microphone.

Nominal Sensitivity—The nominal sensitivity (as assigned by the manufacturer) of the microphone (in mV/Pa). The nominal sensitivity is often the marketed (spec sheet) sensitivity of the microphone (for example, 50 mV/Pa). You can assume that the nominal sensitivity is the same for all microphones on the system.

Sensitivity Offset—Enter the amount (in dB) that the normal sensitivity of the microphone differs from its nominal sensitivity. For example, a nominally 50 mV/Pa microphone with an normal sensitivity of 45 mV/Pa would have a sensitivity offset of $20\log(45/50) = -0.9\text{dB}$

The sensitivity offset is determined by tracking the calibration sensitivities of your microphones over time, then inputting that data into Sound Power Plus.



Note The sensitivity offset of the microphone is used in conjunction with the quality assurance feature in Sound Power Plus that lets you establish an allowable deviation from the microphone's normal sensitivity. Normal values for microphone sensitivity can be established by tracking average values over a period of time and entering the values in the microphone sensitivity file (Excel). Allowable deviations are established based on the laboratory's allowance for calibration measurement uncertainty. The calibration routine displays a control chart that indicates the amount by which each microphone's actual sensitivity differs from its normal sensitivity. Range limits on this control chart let you see when a microphone has calibrated outside of the control limits.

Frequency Response Corrections—Sound Power Plus lets you input frequency response corrections to be applied to the data measured for each microphone. This feature can correct for high-frequency response limitations of measurement microphones. You can enter corrections (in dB) from the microphone calibration frequency response data to be subtracted from the sound pressure level measured in each 1/3-octave band.

The convention used for frequency response corrections is that you enter the frequency response corrections as shown on a standard frequency response chart. For example, for a microphone with a frequency response that was 1.0 dB below the 0 dB reference level at 20 kHz, the value entered into the Excel microphone sensitivity file would be -1.0. Frequency response corrections are conducted as follows:

$$\text{SPL (recorded)} = \text{SPL (measured)} - \text{Frequency Response Correction}$$

In the above example, the -1.0 dB frequency response correction would result in the SPL (recorded) being 1.0 dB greater than the SPL (measured).



Note Carefully check sign conventions for frequency response corrections to ensure they are being applied properly.

Instrument Configuration Files

Instrument configuration files contain all the configuration options for the instrument configuration menus. These files can be saved and loaded from the main menu bar.

Sound Power Plus supports two types of instrument configuration files:

- **Default**—When Sound Power Plus starts, it loads an instrument configuration file that contains the default settings for the instrument. You can edit the default instrument configuration file so that the software loads the instrument configuration that is appropriate for your laboratory.
- **Named Files**—You can create several instrument configuration files and give each file a unique name.

Instrument configuration files are in `.INC` file format and can only be created or edited by using Sound Power Plus.

Measurement Configuration Files

Measurement configuration files contain all of the configuration options for the measurement configuration menus. There are separate measurement configuration files for both sound power and sound pressure level measurement. For each configuration, Sound Power Plus supports two types of measurement configuration files:

- **Default**—When Sound Power Plus starts, it loads sound power and sound pressure level measurement files that contain the default measurement configurations for the laboratory. You can edit the default measurement configuration file so that the software loads the most common measurement configuration that is appropriate for your laboratory each time the software starts.
- **Named Files**—You can create additional measurement configuration files and give each file a unique name. These files can be loaded and saved by using the **Configuration** option on the main menu bar.

Measurement configuration files are in `.PWC` and `.SPC` file formats for sound power level and sound pressure level measurement, and can only be created or edited by using Sound Power Plus.

Reference Spectrum Files

Sound Power Plus lets you create default and named reference spectrum files. These reference spectra are displayed in the graphic window in association with the current graphic display. Reference spectra are displayed as a series of yellow dots on the RTA or test results display.

You can create reference spectrum files for the following spectra:

- **Sound Power Level**—A reference sound power level spectrum that is displayed when the graphic window is displaying sound power level test results.
- **SPL for Sound Power Level**—A reference sound pressure level spectrum that is displayed when the graphic window is displaying the SPL that is used for making sound power measurements.
- **Operator/Bystander Sound Pressure Level**—A reference sound pressure level spectrum that is displayed when the graphic window is displaying the SPL that is used for making operator/bystander sound pressure level measurements.
- **Free Running Sound Pressure Level**—A sound pressure level spectrum that is displayed when the RTA is in a free-running mode.
- **FFT**—An FFT reference spectrum that is displayed when the FFT analyzer is active.

Create reference spectra using controls on the graphic window or in a data table by selecting **Reference»Edit Spectrum** (with the exception of the FFT reference spectrum).

Report Template Files

The sample reports are provided with Sound Power Plus as a part of the `Report Template.xls` file, used to export data into Excel. This section describes the information typically found in the sample reports.

Laboratory Name: <i>Your Laboratory</i> ISO 7779 Sound Power Test Report Report Date: <i>Today's Date</i>	
Test Information	Source Information
Test Name – <i>Test Name Data</i> Test Date – <i>Date/Time Data</i> Test Operator – <i>Test Operator Data</i> Test Description – <i>Test Description Data that can be more than one line long.</i> Comments – <i>Comment Data field that can be more than one line long.</i>	Source Type – <i>Source Type Data</i> Manufacturer – <i>Manufacturer Data</i> Model Number – <i>Model Number Data</i> Serial Number – <i>Serial Number Data</i> Operating Mode – <i>Operating Mode Data</i> Mounting – <i>Mounting Data</i> Dimensions ($l \times w \times h$ mm) – <i>xxxx × xxx × xxx</i> Voltage (v) – <i>Voltage Data</i> Current (A) – <i>Current Data</i> Line Freq (Hz) – <i>LF Data</i> RPM – <i>RPM Data</i>
Meteorological Information	User Information
Temperature (C) – <i>Temperature Data</i> Humidity (%) – <i>Relative Humidity Data</i> Pressure (kPa) – <i>Pressure Data</i>	User Field Name 1 – <i>User Field Data 1</i> User Field Name 2 – <i>User Field Data 2</i> User Field Name 3 – <i>User Field Data 3</i> User Field Name 4 – <i>User Field Data 4</i> User Field Name 5 – <i>User Field Data 5</i> User Field Name 6 – <i>User Field Data 6</i>

Figure B-1. Sample Sound Power Test Report

Measurement Information

All sound power data reported herein has been obtained in accordance with the procedures specified in Clause 6 of ISO 7779, except as noted. The unit under test was operated in accordance with the procedures specified in Annex C of ISO 7779, except as noted. All data is expressed in decibels (dB) with a reference level of 1×10^{-12} watts.

The following measurement setup was utilized to obtain this sound power data:

- **Measurement Surface**—*Measurement Surface Data.*
- **Measurement Surface Dimensions (m)**—*Measurement Surface Dimension Data.*



Supported Drivers

Sound Power Plus supports plug-in driver architecture for multiplexers, which are commonly used in acoustic laboratories. If you are adding a new multiplexer to your system, you can write your own multiplexer driver in LabVIEW. The following drivers are installed with Sound Power Plus by default:

- Brüel & Kjaer 2811—8-channel GPIB microphone multiplexer
- Brüel & Kjaer 2822—12-channel GPIB microphone multiplexer
- Larson-Davis 2210—10-channel, RS-232 microphone multiplexer
- Norsonic 834—10-channel, GPIB microphone multiplexer



Note The Brüel & Kjaer 2811 multiplexer driver performs well when used with newer Brüel & Kjaer 2811 devices. However, some problems have been noted in controlling Brüel & Kjaer 2811 devices featuring six-digit serial numbers. Additionally, older Brüel & Kjaer devices may use communication protocols that are not compatible with Sound Power Plus drivers.

For more information about any of these multiplexers, refer to the documentation that came with your multiplexer.

Adding a New Multiplexer Driver

To add a new multiplexer driver to the system, open the `Multiplexer.ini` configuration file located in the `Sound Power System\Data\Multiplexer Drivers` folder. Add one section and fill in the corresponding key value according to your multiplexer information. The following is an example of the section structure:

```
[Multiplexer Name]
Index=4
Type="Multiplexer Name"
Control Port =GPIB
Input Channel Number=10
Output Channel Number=1
Connected Output Channel=0,0,0,0,0,0,0,0,0,0
Description=Multiplexer Name\Multiplexer driver.vi
```

The index value is the multiplexer index in the configuration file. The description string is the name of the multiplexer driver VI in the `Sound Power System\Data\Multiplexer` folder.

You can view an example driver VI in the `Multiplexer Driver.vi`, which is located in the `\Data\Multiplexer Drivers\Multiplexer Name\` directory. To ensure that the new driver will work properly with Sound Power Plus, verify that the connectors on your new driver VI matches the connectors on the example driver VI.

For more information about any of the supported multiplexers or to develop your own multiplexer driver, refer to the documentation from your multiplexer vendor.

Technical Support Resources

Web Support

National Instruments Web support is your first stop for help in solving installation, configuration, and application problems and questions. Online problem-solving and diagnostic resources include frequently asked questions, knowledge bases, product-specific troubleshooting wizards, manuals, drivers, software updates, and more. Web support is available through the Technical Support section of ni.com.

NI Developer Zone

The NI Developer Zone at ni.com/zone is the essential resource for building measurement and automation systems. At the NI Developer Zone, you can easily access the latest example programs, system configurators, tutorials, technical news, as well as a community of developers ready to share their own techniques.

Customer Education

National Instruments provides a number of alternatives to satisfy your training needs, from self-paced tutorials, videos, and interactive CDs to instructor-led hands-on courses at locations around the world. Visit the Customer Education section of ni.com for online course schedules, syllabi, training centers, and class registration.

System Integration

If you have time constraints, limited in-house technical resources, or other dilemmas, you may prefer to employ consulting or system integration services. You can rely on the expertise available through our worldwide network of Alliance Program members. To find out more about our Alliance system integration solutions, visit the System Integration section of ni.com.

Worldwide Support

National Instruments has offices located around the world to help address your support needs. You can access our branch office Web sites from the Worldwide Offices section of ni.com. Branch office Web sites provide up-to-date contact information, support phone numbers, e-mail addresses, and current events.

If you have searched the technical support resources on our Web site and still cannot find the answers you need, contact your local office or National Instruments corporate. Phone numbers for our worldwide offices are listed at the front of this manual.

Glossary

Prefix	Meaning	Value
m-	milli-	10^{-3}
k-	kilo-	10^3

Numbers/Symbols

% Percent.

A

A Amperes.

actual sensitivity The apparent sensitivity of the sensor during a particular calibration.

anechoic A test environment with acoustic wall treatments such that essentially no sound energy is reflected.

ANSI American National Standards Institute.

Awtd A-weighted. A standard frequency weighting applied to acoustic spectra to provide a single number level descriptor.

B

bel 1 bel = 10 dB

BNC Series (connector) A radio frequency connector covered by military specification.

C

C Celsius.

D

DAQ	Data acquisition.
dB	Decibel.
DSA	Dynamic Signal Analyzer.
DSP	Digital Signal Processing.

E

ECMA	European Computer Manufacturers Association.
------	--

F

FFT	Fast Fourier Transform.
full anechoic	An anechoic chamber treated on all walls, ceiling, and floor surfaces.

G

GPIB	General Purpose Interface Bus.
------	--------------------------------

H

hemi-anechoic	An anechoic chamber treated on the walls and ceiling, but with an acoustically reflective floor.
Hz	Hertz.

I

I/O	Input/output.
ICP	Integrated Circuit Piezoelectric.

Impulse A-weighting Applies a time constant to a measurement to detect energy in impulsive sounds.

ISO International Standards Organization.

K

K2 A correction, in decibels, applied to surface averaged sound pressure level data to correct for the influence of the acoustic test environment on the measurement result. Defined and used as in ISO 3744.

M

m Meters.

measurement session A series of measurements on a device under test that may include sound power and sound pressure level measurements.

mux Multiplexer.

N

nominal sensitivity The marketed sensitivity of a sensor.

normal sensitivity The “everyday use” sensitivity of a sensor. You determine the normal sensitivity by tracking the sensor’s sensitivity over time.

O

OLE Object Linking and Embedding. A Microsoft standard protocol for allowing applications that use OLE technology to share and link to data in other applications.

P

Pa Pascal.

parallelepiped A rectangular “box” measurement surface, which is defined in ISO 7779.

Glossary

PR Prominence ratio.

PWL Sound power level.

R

RPM Revolutions per minute.

RS-232 An industry standard interface for connecting serial devices.

RTA Real time analyzer.

S

sensitivity offset The amount by which the sensor normally deviates from its nominal value.

SPL Sound pressure level.

T

TNR Tone-to-noise ratio.

V

V Volt.

VI Virtual instrument.

W

.wav An industry standard format for sound files.

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