

# Sound Power System

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## Operator Manual

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# About This Manual

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This manual provides an overview of the Sound Power System. It includes information about configuring your software and using it to take acoustic measurements. The Sound Power System is designed for use with Windows 2000/NT/98/95.

## Conventions

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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.

`monospace italic`

Italic text in this font denotes text that is a placeholder for a word or value that you must supply.

## Related Documentation

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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](http://www.ansi.org)
- ECMA-74. ECMA standards are available through the ECMA website at [www.ecma.ch](http://www.ecma.ch)
- ISO 3744, 3745, and 7779. ISO standards are available through the International Organization for Standardization website at [www.iso.ch](http://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](http://www.ince.org)

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# Overview of the Sound Power System

The National Instruments Sound Power System automates the acquisition and analysis of computer and business equipment noise emission measurement data. The Sound Power System implements the acoustic measurement procedures defined in ISO 7779 and ECMA-74. In addition, the software supports a number of user-configurable options so that you can implement several other basic sound power and sound pressure level measurement standards, such as ISO 3744 and ISO 3745. 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

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The following are the minimum system requirements needed to run the Sound Power System:

- Pentium computer running Windows 2000/NT/98/95.
- 64 MB RAM.
- 50 MB available hard drive space.
- National Instruments NI 4551 or NI 4552 DSA board (includes the BNC 2140 breakout box).
- Real-time octave analyzer software 1.1 or later.
- NI-DAQ 6.5 or later.
- A GPIB board, if you plan to use a GPIB-based multiplexer.
- Microsoft Excel 97 or later (required to export data and import microphone sensitivity and frequency response data).

# Program Overview

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The Sound Power System 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

The Sound Power System 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 as a measurement device a National Instruments NI 4551 or NI 4552 DSA board.

## Drivers

The Sound Power System 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 the Sound Power System.

## Data Files

The software generates a data file for each test serial number. This file contains test documentation, measurement configuration information, sound power data, and sound pressure level data. The software also provides an export-to-Excel feature that allows all test information to be exported into an Excel template file. This lets you 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 re-configure standard configurations. For more information, refer to Appendix B, [Program and Data Files](#).

# User Interface and General Program Layout

The following figure shows the Sound Power System user interface, which consists of a three-window screen layout.

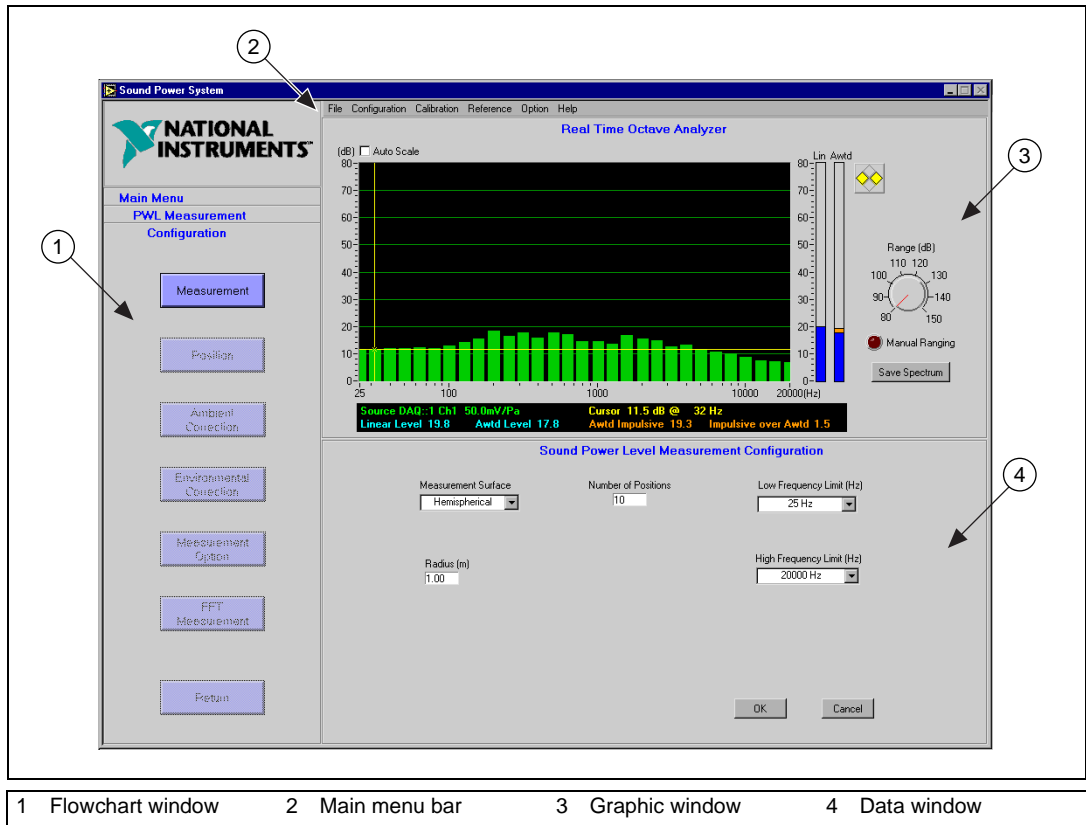





Figure 1-1. Sound Power System User Interface

## 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 on a button, you sequentially execute each step necessary to complete a routine. Clicking on 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
	Button is available. All previous required steps are complete.
	Button 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 on **OK** in a data window) or when you load data that satisfies the step.

Click on 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, the Sound Power System 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, the Sound Power System 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, the Sound Power System 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 1/3-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 1/3-octave band. When not performing a particular measurement, these indicators display the instantaneous “slow” sound pressure level (SPL). The following figure shows the parts of an RTA display.

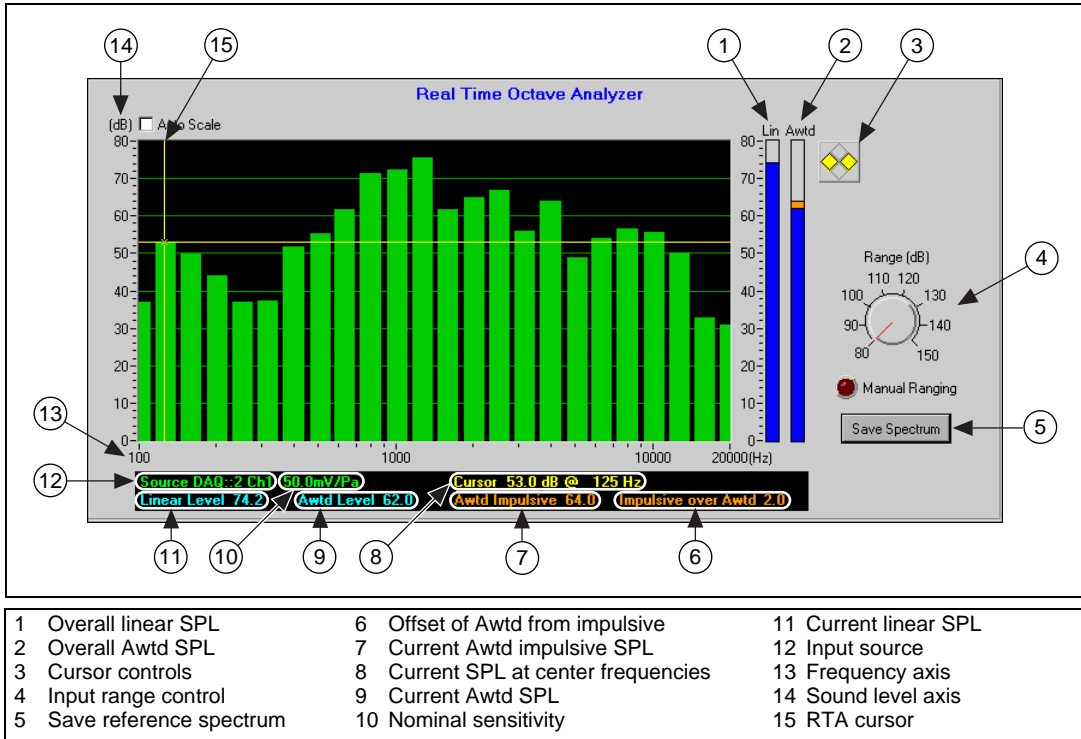


Figure 1-2. Sample RTA Display Window

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 (Awt'd) SPL. The Awt'd 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.



## Alpha-Numeric Indicators

A series of alpha-numeric indicators display the following information:

- The input source (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 1/3-octave band selected.
- 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 alpha-numeric 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 alpha-numeric 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 on the upper or lower limit levels and edit the value displayed. The axis automatically re-scales.

The RTA display includes the following controls:

**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 on 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. The following figure shows the parts of an FFT display.

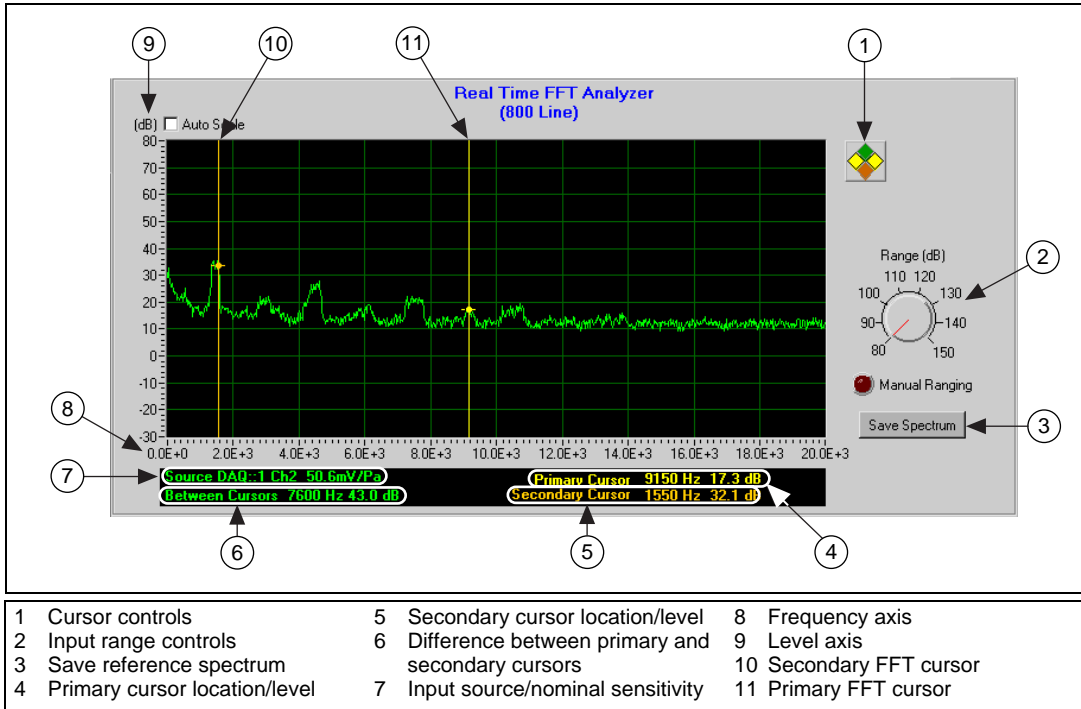


Figure 1-3. Sample FFT Display Window

The Sound Power System 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.

### Alpha-Numeric Indicators

A series of alpha-numeric indicators display the following information:

- The source of the current FFT spectrum being acquired (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 alpha-numeric display.

When the two cursors select frequencies on the same spectrum, the alpha-numeric 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 which 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 on the upper or lower limit levels and edit the value displayed. The axis automatically re-scales.

The FFT display includes the following controls:

**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 on 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. The following figure shows the parts of a test results display.

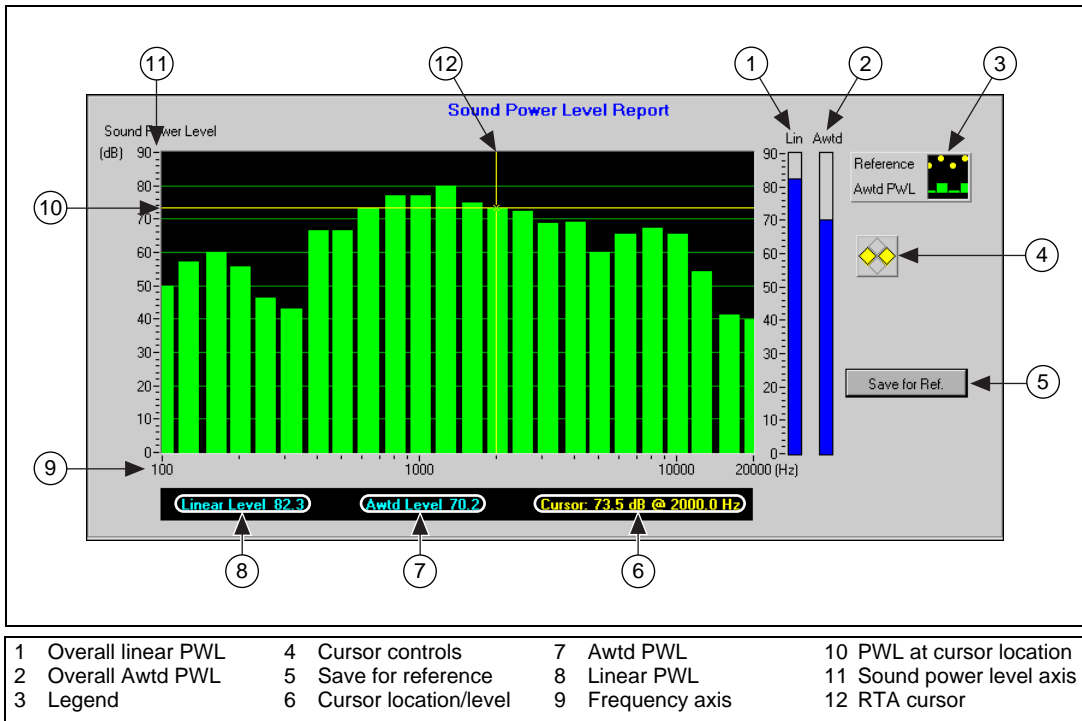


Figure 1-4. Sample Test Results Window (PWL Shown)

### Alpha-Numeric Indicators

A series of alpha-numeric indicators display the following information:

- The linear sound power level.
- The Awt'd 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 alpha-numeric 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 on the upper or lower limit levels and edit the value displayed. The axis automatically re-scales.

**Save Spectrum**—Click on this button to save the current sound power level result as a reference spectrum. A dialog box prompts you to enter a file name.

## Main Menu Bar

The main menu bar (at the top of the Sound Power System) is always visible and active. This menu bar provides a way for you to do 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. You can also configure auto-range settings from this menu.

- 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.

## 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 the Sound Power System and open the Sound Power System online help.

**Show Help**—Displays the Sound Power System online help file.

**About**—Displays information about the version of the Sound Power System.

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# Installation and Configuration

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

## Installation

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Follow these instructions to install your Sound Power System software.

### Configure Windows Settings

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

- Set screen resolution to at least  $1024 \times 768$ ; maximum colors supported by hardware (preferably 256 or greater).
- Set system to display small fonts.
- Make sure that the **Always on top** option in the Windows taskbar properties is not selected.

### Install Hardware

The Sound Power System requires the NI 4551/4552 DSA instrument to be installed on your computer. Make sure the board and instrument driver are properly installed. Refer to the documentation that came with your board for detailed installation and configuration instructions. Follow these instructions to install your NI 4551 or NI 4552 board:

1. Power off your system.
2. Install the board in a full-length PCI slot.
3. Boot the system to auto-detect hardware.
4. Verify your board installation:
  - a. Open **Measurement and Automation** from your computer.
  - b. Double-click on **Devices and Interfaces**.
  - c. Verify that the board is listed in the right window frame and that no errors have been detected.

## Install 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.
2. Install the GPIB board in a free PCI slot.
3. Boot the system to auto-detect hardware.
4. On the **GPIB Configuration** screen, select the following options:
  - GPIB = 0.
  - Select **Board**; set board type to PCI-GPIB.
  - Click on **Configure**.
5. Verify your board installation:
  - a. Open **Measurement and Automation** from your computer.
  - b. Double-click on **Devices and Interfaces**.
  - c. Verify that the board is listed in the right window frame and that no errors have been detected.

## Install BNC 2140 Breakout Box

Follow these instructions to install the BNC 2140 breakout box:

1. Plug the cable into your NI 4551 or NI 4552.
2. Set all switches to **SE** (Single Ended).
3. Turn Integrated Circuit Piezoelectric (ICP®) **Off** (main and individual), unless you are using ICP microphones.

## Install Sound Power System Software

1. Close all programs, if you have any running.
2. Insert the Sound Power System CD into your CD drive.
3. The CD has autorun capabilities, so it should run automatically. If it does not launch automatically, you can start the installation by running `setup.exe` from the setup folder.
4. Follow the instructions on the screen to complete the installation.



# Configuration

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The rest of this chapter describes how to configure your instruments and measurements. There are two ways to provide configuration data to the Sound Power System: either load configuration information into the Sound Power System from a file, or enter new configuration data.

## Load a Configuration File

Select **Configuration»Load** to load settings from a file. A dialog box prompts you to enter the name of the file to load. The configuration file must be compatible with the number of boards and devices currently installed on the system; otherwise, an error is returned. The configuration data file must be in Sound Power System native file format.

You can 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** 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

Select **Configuration»Settings** to create or edit the instrument, PWL measurement, SPL measurement, or auto-ranging configuration settings. Selecting this option activates the password entry dialog box (except for the auto-ranging configuration settings). 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 the 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. The file is then saved in the Sound Power System native file format.

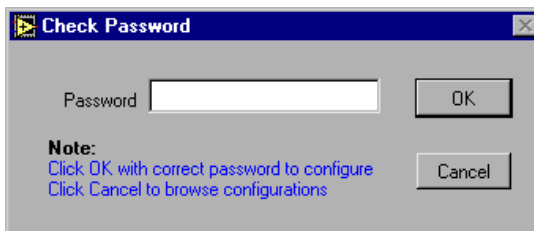


**Note** Default files are loaded each time the Sound Power System is launched or any time the system defaults are loaded.

## Password Protection

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All instrument and measurement configuration routines are password protected. Each time you access these routines, a dialog box (similar to the following) appears that requires you to enter the password.



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

If you do not enter the password, you can still view instrument and measurement configuration options, but you cannot edit or save them.

You can set a new password or change the password by selecting **Option» New Password**. To disable the password protection feature, use a blank field as the password.



**Note** The Sound Power System ships without an initial password (no characters in the password field). If you lose or forget your password, contact National Instruments technical support for assistance.

# Configure the Instruments

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The following sections describe how to configure your instruments. You need to make sure you have saved instrument configuration files before you make measurements.

You can either load configuration information into the Sound Power System from a file, or enter new configuration data. 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 System native file format. Select **Configuration»Load»Default»Instrument Configuration** if you want to load the default instrument configuration files.

To enter or change configuration data, launch the instrument configuration routine by selecting **Configuration»Settings»Instrument**, then select a device to configure. This launches the Instrument Configuration flowchart window, from which you can configure other devices. Settings that you can edit include:

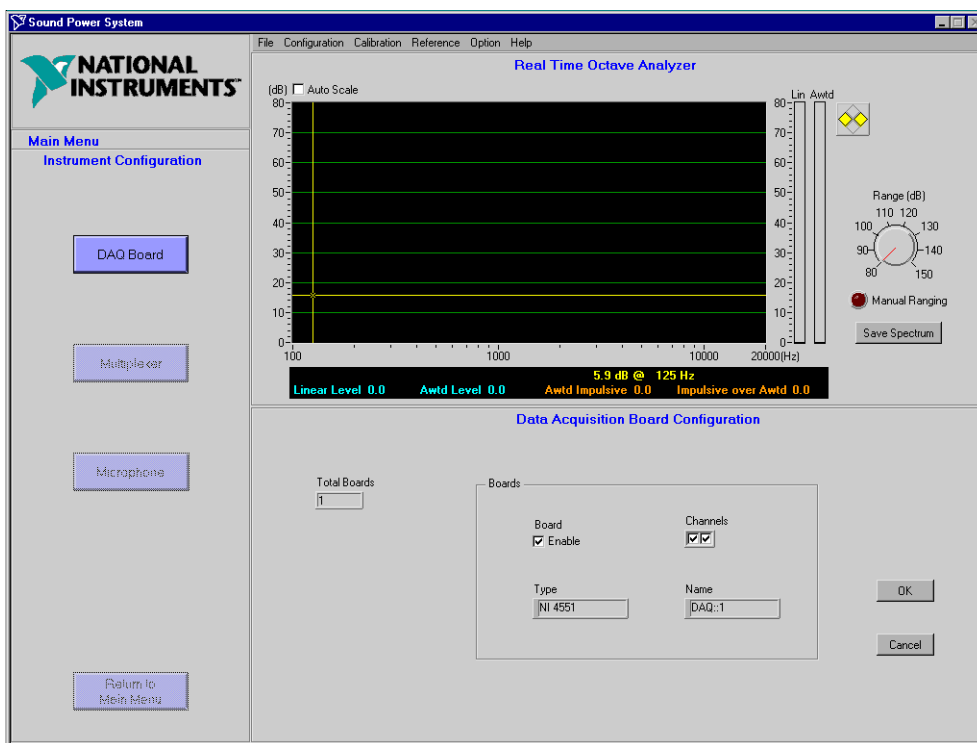
- **Board**—Controls and indicators related to the number of DAQ boards and configured measurement channels for the system.
- **Multiplexer**—Controls and indicators that let you select and configure multiplexers on each configured instrument channel.
- **Microphone**—Controls and indicators that let you assign microphones to each configured input channel (DAQ direct input or through 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 can browse, but not change, 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

The following figure shows the Sound Power System with the Data Acquisition Board Configuration data window active.



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

**Board**—Select this check box to enable the DAQ board. This check box needs to be selected for at least one board; otherwise, you will not be able to do any measurements or configuration.

**Type**—The Sound Power System automatically detects and identifies the type of DAQ board installed in the system.

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

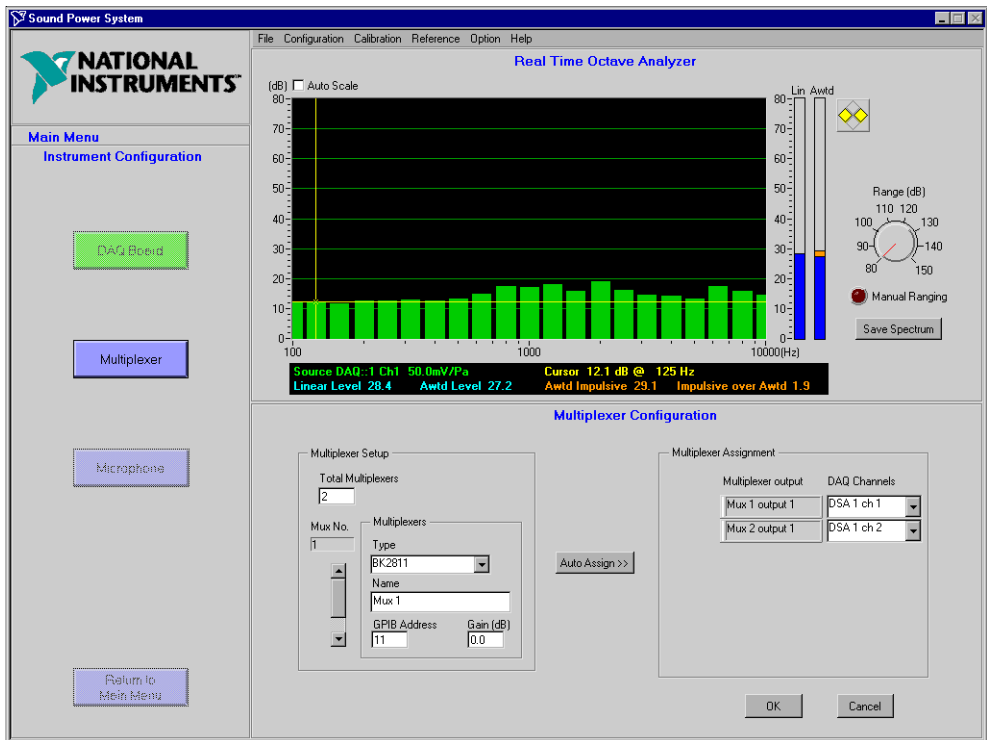
**Name**—The name assigned by the software that the system uses to refer to this DAQ board.

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

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

## Multiplexer Configuration

The following figure shows the Sound Power System with the Multiplexer Configuration data window active.



Use this window to set up your multiplexers. You can access this window in the following ways:

- Select **Configuration»Settings»Instrument»Multiplexer** from the main menu bar.
- When the Instrument Configuration flowchart window is active, click on the **Multiplexer** button.

Each DAQ input channel is capable of supporting a multiplexer. Drivers for several common microphone multiplexers are included with the Sound Power System. Appendix C, *Supported Drivers*, describes each of these drivers.



**Note** This data window lets you configure more than one multiplexer. Enter the information for the first multiplexer, then move the scroll bar to toggle through the configuration for each additional multiplexer. Do not click on **OK** until you have finished configuring all multiplexers.

## Multiplexer Setup

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



**Note** If you do not use a multiplexer (that is, you connect the microphones directly to the BNC 2140 inputs), set the number of multiplexers equal to the number of microphones and select **None** for the Multiplexer Type.

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

**Multiplexer Type**—Click on the arrow control to select your multiplexer. For a list of multiplexers supported by the system, refer to Appendix C, *Supported Drivers*. If you do not use a multiplexer, select **None** for the Multiplexer Type.

**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 text box.

**GPIB Address/Serial Port**—This field varies based on whether your multiplexer is GPIB or serial. Enter the GPIB 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 on this button if you want the software 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.

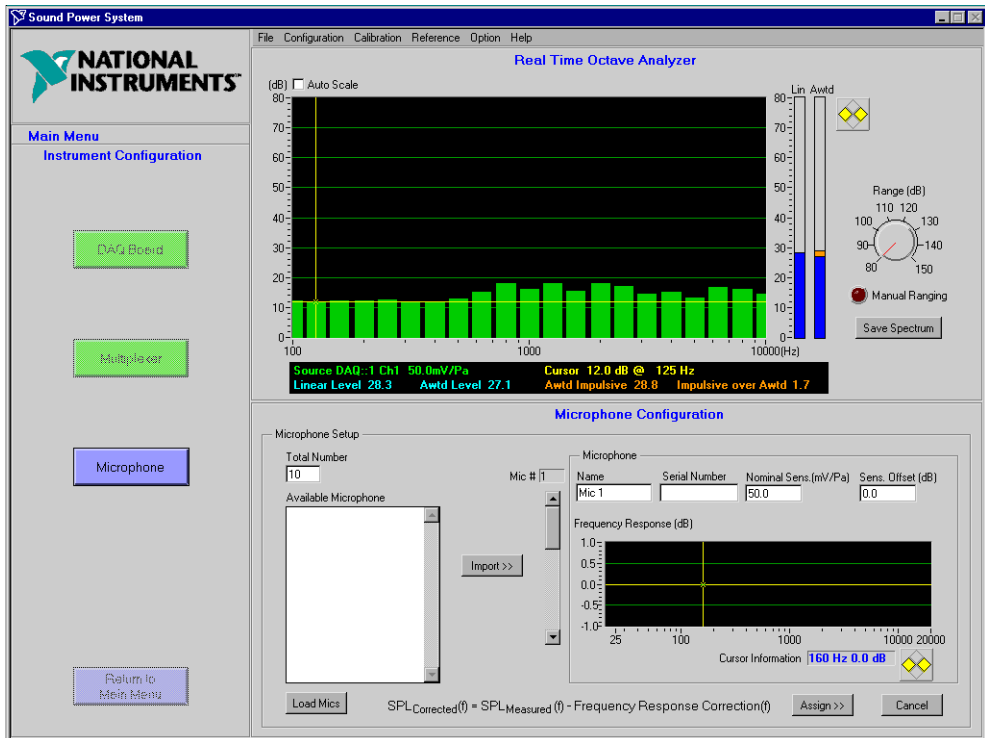
**DAQ Channels**—Use this list box to select an input channel on the DAQ board to associate with the multiplexer output.

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

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

## Microphone Configuration

The following figure shows the Sound Power System with the Microphone Configuration data window active.



Use this window to establish a relationship between your microphones and measurement channels. You can access this window in the following ways:

- Select **Configuration»Settings»Instrument»Microphone** from the main menu bar.
- When the Instrument Configuration flowchart window is active, click on the **Microphone** button.

Based on the **Total Number**, the system assigns a serially numbered group of microphones, beginning with microphone one (Mic 1). For a description of how the 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, with the only restriction being that each microphone must be assigned to a unique multiplexer channel (or DAQ input channel if no multiplexer is used).

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

**Load Mics**—Click on this button to import the microphone data from an Excel microphone sensitivity file. When you click on **Load Mics**, a file window appears from which you can choose a microphone sensitivity file to load. Select a file, then click on **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**—When you use the **Load Mics** button, this selection box lists the available configured microphones.

**Mic #**—Move the scroll bar to toggle through the configuration for each of the microphones.

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

## Microphone

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

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

**Serial Number**—Enter a serial number that uniquely identifies the microphone. You can enter the serial number 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). You can enter the nominal sensitivity by editing this field or importing the nominal sensitivity 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 with 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. You can load them into the Sound Power System by clicking on the **Load Mics** button.

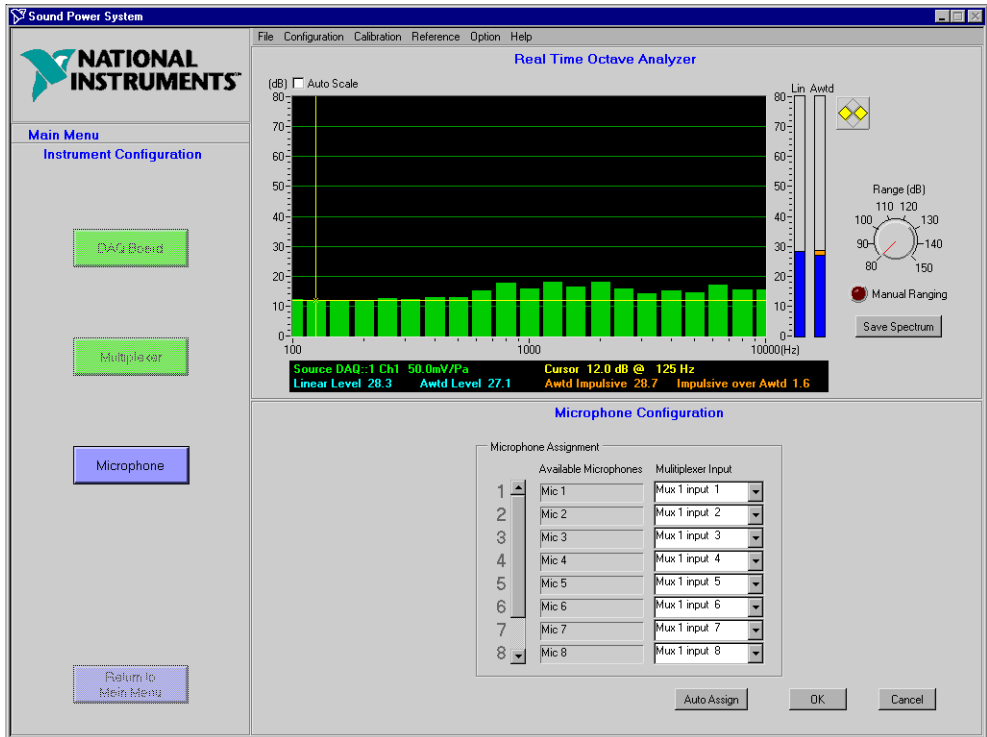
**Cursor Information**—This indicator returns the frequency response correction for the selected 1/3-octave band.

**Assign**—When you click on this button, a Microphone Configuration screen appears. The next section describes the Microphone Configuration screen.

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

## Microphone Assignment

The following figure shows the Sound Power System with the Microphone Configuration assignment data window active.



Use this window to assign your microphone to a multiplexer input channel (or DAQ input channel if no multiplexer is used). You can access this window in the following ways:

- Select **Configuration»Settings»Instrument»Microphone** from the main menu bar, then click on the **Assign** button.
- When the Instrument Configuration flowchart window is active, click on the **Microphone** button, then click on the **Assign** button.

**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 the **Multiplexer Input** list box to assign a multiplexer input channel to an available microphone.

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



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

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

**Cancel**—Click on 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. The file is then saved in the Sound Power System native file format. Select **Configuration»Save»Default»Instrument Configuration** if you want to save the current instrument configuration to the system instrument configuration default file `Global_Instrument Configuration_Default.Inc`.

## Configure the Sound Power Level Measurement

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

You can either load configuration information into the Sound Power System 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 in Sound Power System native file format. Select **Configuration»Load»Default»PWL Measurement Configuration** if you want to load the default sound power level 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.

To enter or change configuration data, launch the sound power level measurement configuration routine by selecting **Configuration»Settings»Sound Power Level Measurement**, then select a setting to

configure. This launches the PWL Measurement Configuration flowchart window, from which you can configure other sound power level measurement settings. Sound power level measurement settings that you can edit include:

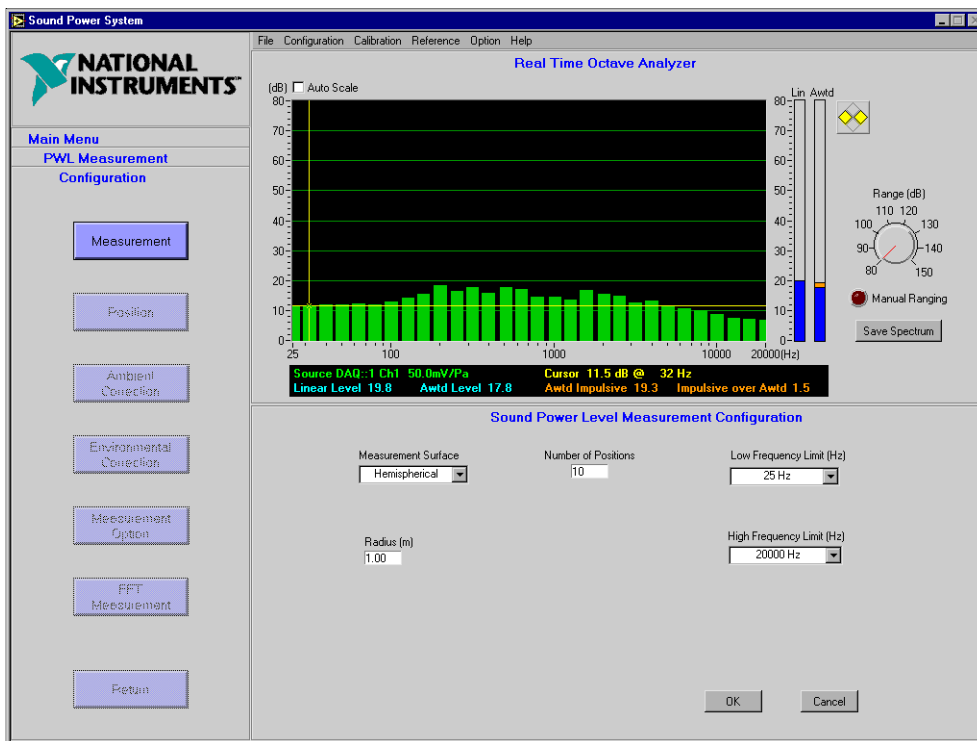
- **Measurement**—Controls and indicators that let you configure the basic measurement parameters for a sound power level measurement.
- **Position**—Controls and indicators that let you configure measurement positions and assign microphones to each position.
- **Ambient Correction**—Controls and indicators that let you configure the method to use while conducting ambient noise corrections.
- **Environmental Correction**—A table that lets you input a series of corrections for the effect of the acoustic environment on the sound pressure level measurement made for sound power, that is, K2 values.
- **Measurement Option**—Controls and indicators that let you configure several measurement options associated with the sound power level routine.
- **FFT Measurement**—Controls and indicators that let you configure the measurement options for the source SPL FFT 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

The following figure shows the Sound Power System with the Sound Power Level Measurement Configuration data window active.



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

**Measurement Surface**—Select one of the following measurement surfaces from the list box:

- **Hemispherical** measurement surface, for hemi-anechoic chambers.
- **Spherical** measurement surface, for full-anechoic chambers.
- **Parallelepiped (box)** measurement surfaces, for hemi-anechoic chambers.



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

**Radius (m)**—Choosing the **Hemispherical** or **Spherical** surface enables the **Radius (m)** control. You can specify a radius from 0.50 to 4.00 meters.

**Length, Width, Height**—Choosing the **Parallelepiped** surface enables the **Length, Width, and Height** controls (not shown). The dimension fields follow the dimensioning conventions defined by ISO 7779.

**Number of Positions**—Use this text box to specify how many measurement positions you want for the sound power measurement. Because you can assign each microphone to more than one position, the number of measurement positions is independent of the number of microphones available for measurement.

**Low Frequency Limit (Hz)**—Use this list box to select the lowest measurement frequency for the sound power level measurement. The default measurement setup 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 sound power measurement. The default measurement setup 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.



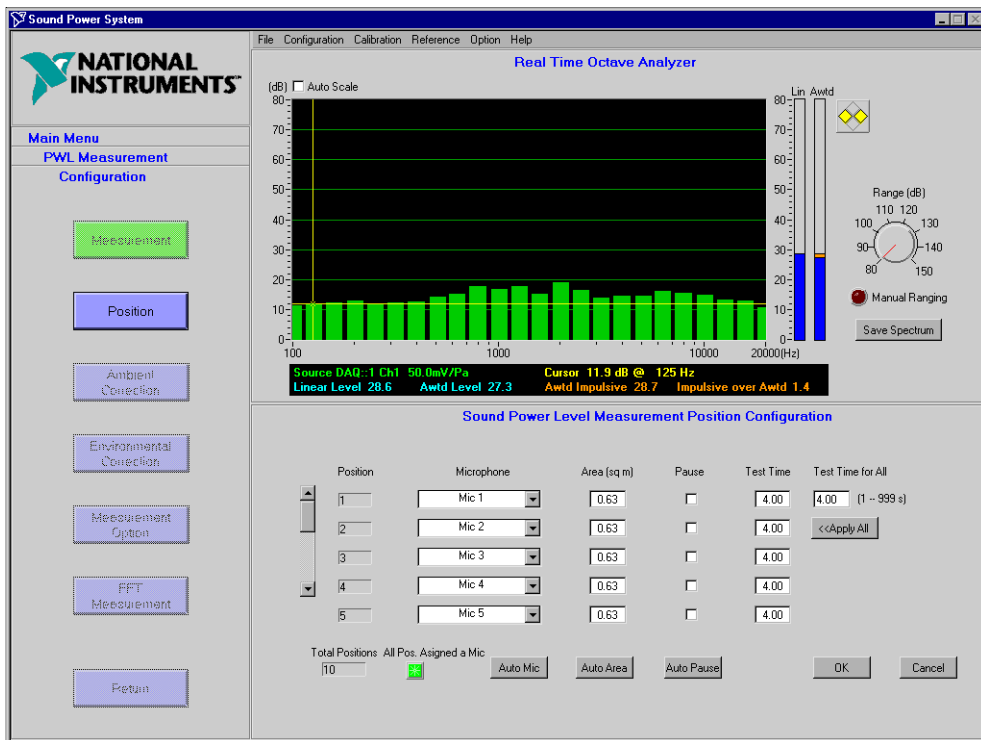
**Note** The Sound Power System supports measurements over a frequency range of 25 to 20,000 Hz. The **Low Frequency Limit** must be less than the **High Frequency Limit**.

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

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

## Position Configuration

The following figure shows the Sound Power System with the Sound Power Level Measurement Position Configuration data window active.



Use this window to assign a microphone configured during instrument configuration to each measurement position. You can access this window in the following ways:

- Select **Configuration»Settings»Sound Power Level Measurement»Position** from the main menu bar.
- When the PWL Measurement Configuration flowchart window is active, click on the **Position** button.

**Position**—This indicator 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**—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 you configured in Microphone Configuration. You can click on the **Auto Mic** button to assign microphones sequentially to each position.

**Auto Mic**—Click on this button if you want to automatically assign a microphone to each position in the most logical order (based on the number of microphones configured on the system in the Microphone Configuration and the number of positions configured in the Measurement Configuration). Microphones are assigned in sequential order to each position until all microphones have been used, then the sequence is repeated until all positions have been assigned.



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

**Area (sq m)**—Use this list box to enter a value (in square meters) for the area associated with each measurement position. This surface area is used to area weight the surface average sound pressure level (as described in ISO 3745, section 7.7.1.2). You can click on the **Auto Area** button to evenly divide the total measurement surface area over all measurement positions.

**Auto Area**—Click on this button to automatically divide the total measurement surface area (determined from the measurement surface size and shape selected during sound power level Measurement Configuration) evenly between each measurement position. If each measurement position in the sound power measurement is representative of the same area, this is the preferred way to complete the **Area** field for each position.



**Note** When you click on **OK**, the software checks the area value. If the sum of the areas you entered differs from the total surface area of the measurement surface calculated (based on the size and shape configured in sound power level Measurement Configuration) such that an error of greater than 0.1 dB would be generated, an error alert appears. You must reconcile the individual area fields with the total measurement surface area before the position configuration will be accepted.

**Pause**—Select this check box if you want the measurement sequence to pause after a measurement position. This is useful if you need to move a microphone to a new position between measurements.

**Auto Pause**—Click on this button if you want 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, the system would automatically assign a pause to positions two, four, six, and eight.

**Test Time**— Enter the length of time (in seconds) you want the system to sample each microphone when determining the  $L_{eq}$  value for each position. Valid values are 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**—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 on the **Apply All** button to apply the **Test Time for All** value to the **Test Time** field for each position.

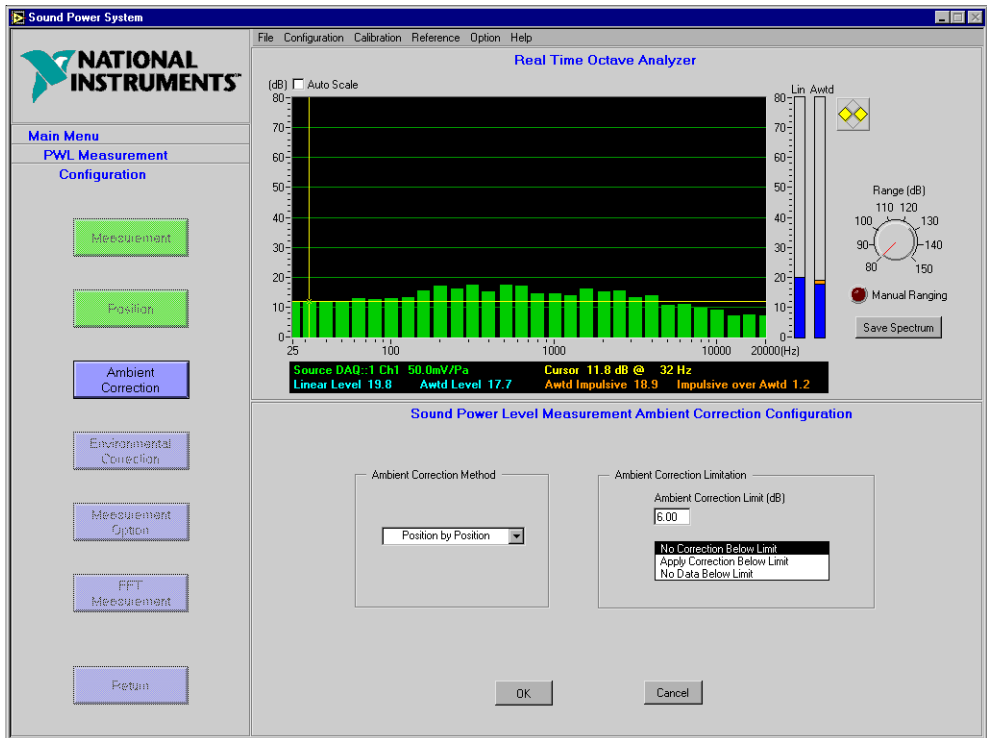
**All Pos. Assigned a Mic**—If the **All Pos. Assigned a Mic** indicator is lit green, all configured measurement positions are assigned to a valid microphone. This indicator must be green for you to save the position configuration without an error.

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

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

## Ambient Correction Configuration

The following figure shows the Sound Power System with the Sound Power Level Measurement Ambient Correction Configuration data window active.



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 in the following ways:

- Select **Configuration»Settings»Sound Power Level Measurement»Ambient Correction** from the main menu bar.
- When the PWL Measurement Configuration flowchart window is active, click on the **Ambient Correction** button.

**Ambient Correction Method**—Select a method to use to make 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 with the ambient sound pressure level recorded at that position, prior to surface averaging. The default measurement configuration file is set with this option initially selected.
- **Surface Average**—Ambient corrections are applied after the source and ambient sound pressure level data have been averaged for all measurement positions. The surface average ambient sound pressure level is then used to correct the surface averaged source sound pressure level.

## Ambient Correction Limitation

These controls let you 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.

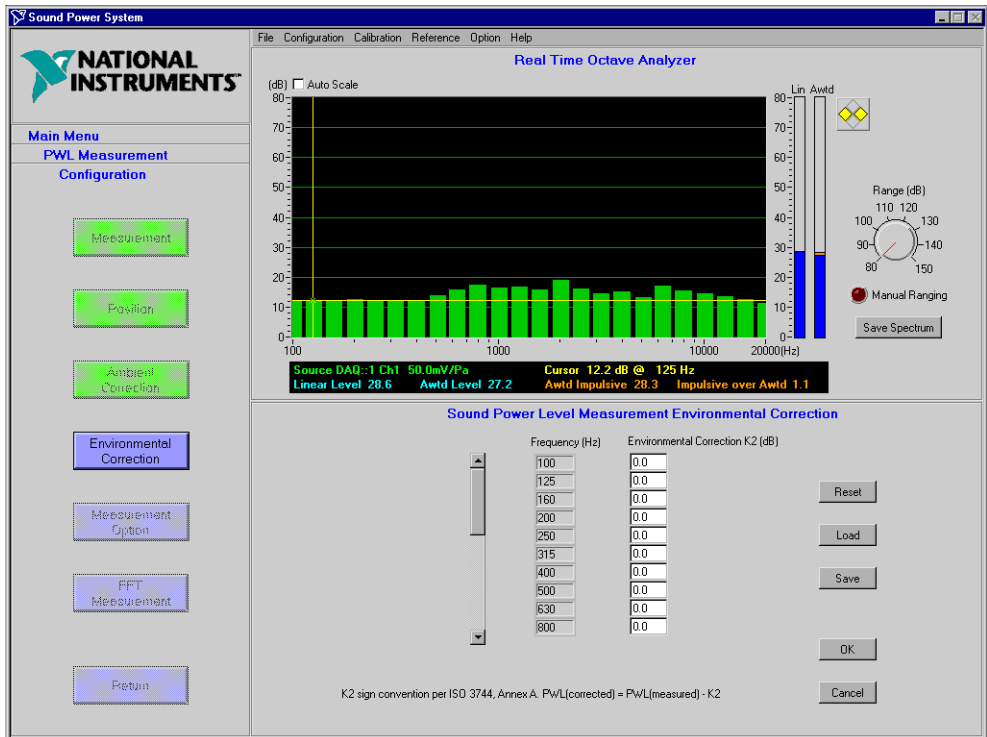
- **Ambient Correction Limit (dB)**—Enter a value for the difference between the source and ambient sound pressure levels, below which either no ambient corrections are applied or a fixed correction is applied. The initial value assigned in the default measurement configuration file is 6.0 dB.
- **Correct 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 on this button to accept the values you entered and exit the ambient correction configuration.

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

## Environmental Correction Configuration

The following figure shows the Sound Power System with the Sound Power Level Measurement Environmental Correction data window active.



Use this window to input the environmental corrections to apply as part of a sound power measurement. This 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 in the following ways:

- Select **Configuration»Settings»Sound Power Level Measurement»Environmental Correction** from the main menu bar.
- When the PWL Measurement Configuration flowchart window is active, click on the **Environmental Correction** button.



**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 on this button to revert to the previously saved K2 values.

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

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



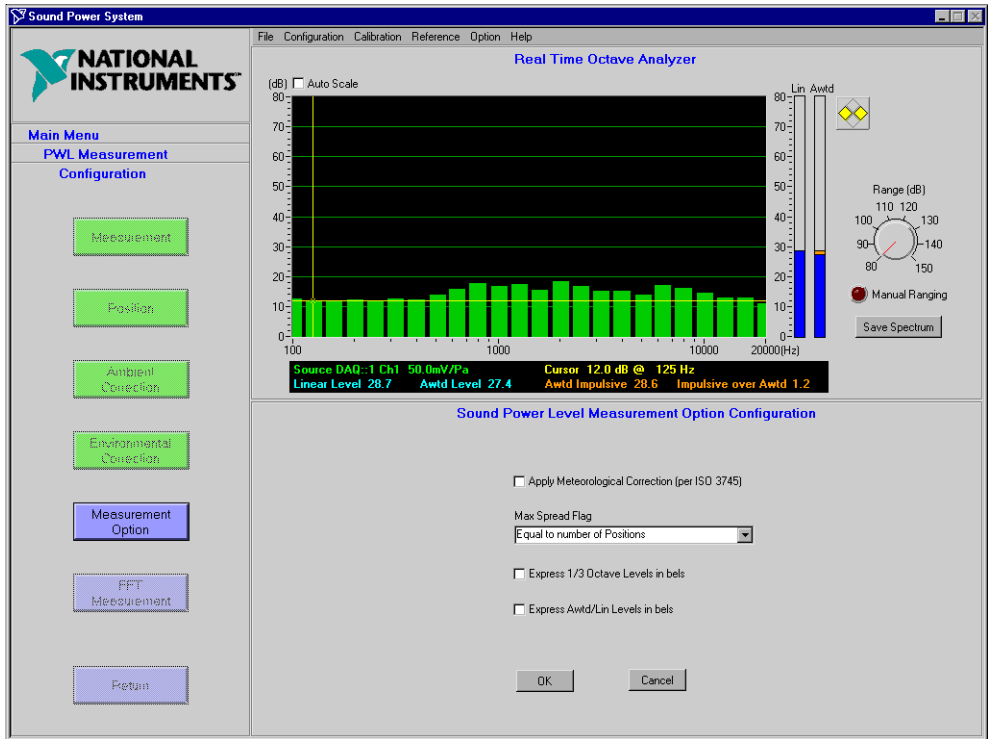
**Note** You can also save and load K2 values using the commands on the main menu bar. The difference between using the on-screen buttons and the menu bar is that clicking on the **Save** and **Load** buttons only save and load K2 values. When you save or load a sound power level measurement configuration file through the main menu, all six measurement configuration screens are loaded, not just the K2 values.

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

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

## Measurement Option Configuration

The following figure shows the Sound Power System with the Sound Power Level Measurement Option Configuration data window active.



Use this window to configure the measurement options for the sound power measurement routine. You can access this window in the following ways:

- Select **Configuration»Settings»Sound Power Level Measurement»Measurement Option** from the main menu bar.
- When the PWL Measurement Configuration flowchart window is active, click on the **Measurement Option** button.

**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 input in **Test Documentation»Meteorological Information** is used to calculate this correction. (For more information, see the *Meteorological Information* section in Chapter 3, *Document 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 has this option selected.
- **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 the above options lets you work with sound power levels in bels in order to be consistent with product declaration standards.

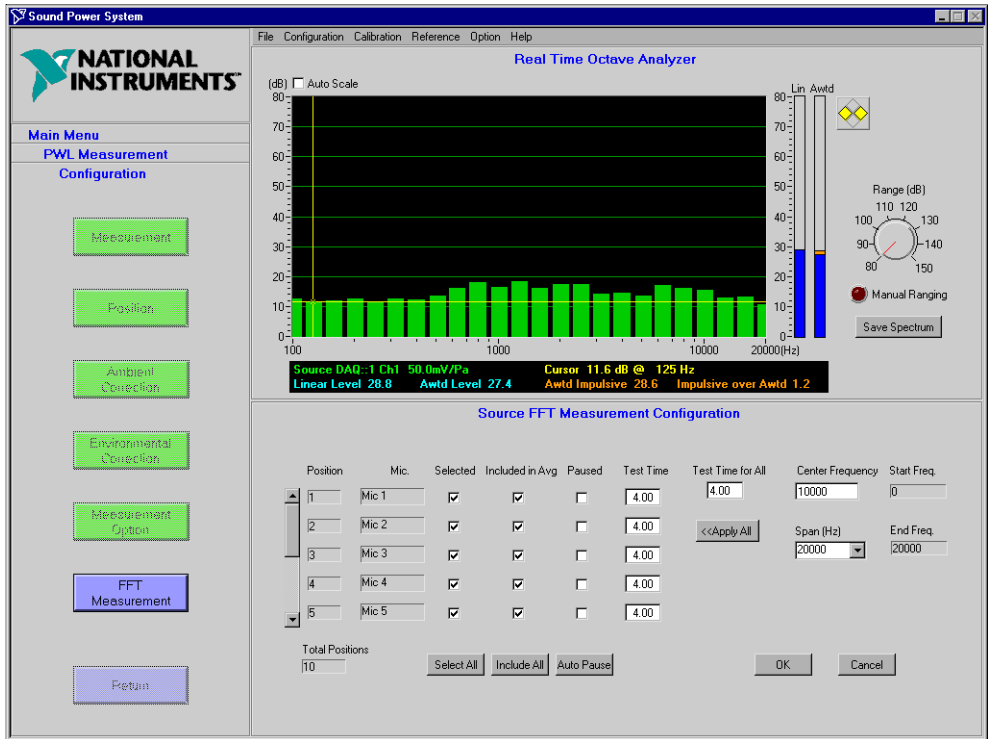
**OK**—Click on this button to accept the values you entered and exit the measurement options configuration.

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



## FFT Measurement Configuration

The following figure shows the Sound Power System with the Source FFT Measurement Configuration data window active.



Use this window to configure parameters to measure sound pressure levels at any configured microphone position using an FFT analyzer. You can access this window in the following ways:

- Select **Configuration»Settings»Sound Power Level Measurement»FFT Measurement** from the main menu bar.
- When the PWL Measurement Configuration flowchart window is active, click on the **FFT Measurement** button.



**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 in the Measurement Configuration.

**Mic**—The microphone name that you assigned to this position in the Position Configuration.

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

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

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

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

**Paused**—Select a check box to designate the position(s) you want the automatic measurement sequence to pause after measuring. This is useful if you need to move a microphone to a new position between measurements.

**Auto Pause**—Click on this button if you want the software to automatically determine where pauses are needed.

**Test Time**—Enter the length of time (in seconds) that you want the system to measure each position.

**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 on **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. It is determined as the center frequency minus one half of the span.

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

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

**Cancel**—Click on 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. The file is then saved in the Sound Power System native file format. Select

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

## Configure the Operator/Bystander Sound Pressure Level Measurement

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The following sections describe how to configure your operator/bystander sound pressure level measurement.

You can either load sound pressure level measurement configuration information into the Sound Power System from a file, or enter new configuration data. To load sound pressure level 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 System native file format. Select **Configuration»Load»Default»SPL Measurement Configuration** if you want to load the default operator/bystander sound pressure level 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.

To enter 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 SPL Measurement Configuration flowchart window, from which you can configure other sound pressure level measurement settings. Sound pressure level measurement settings that you can edit include:

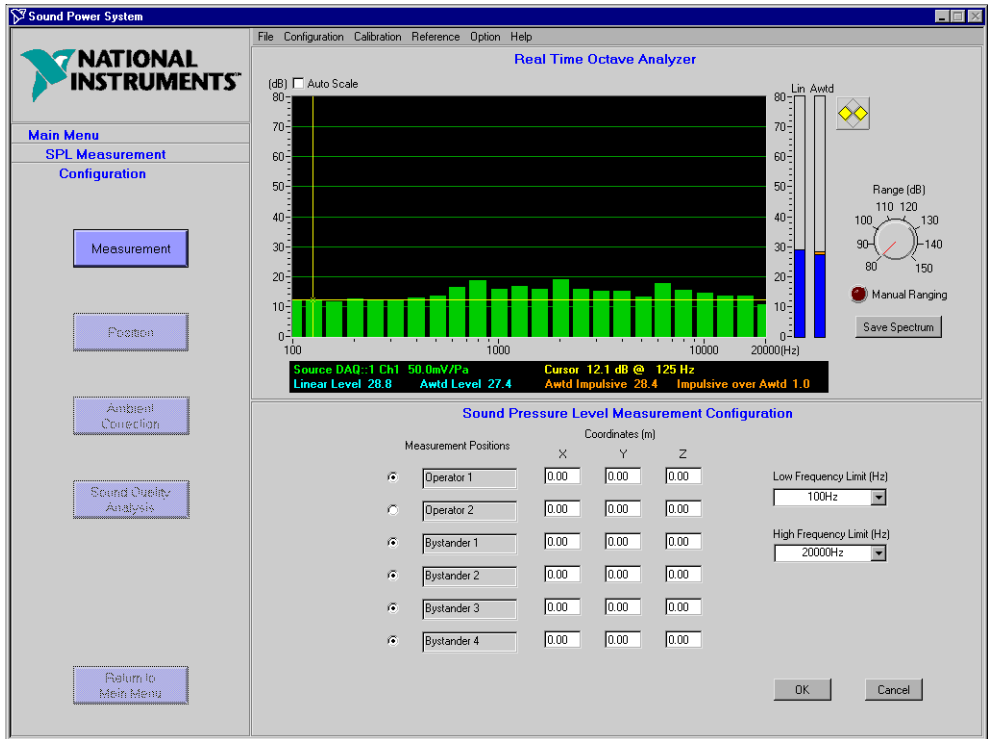
- **Measurement**—Controls and indicators that let you configure the basic measurement parameters for an operator/bystander sound pressure level measurement.
- **Position**—Controls and indicators that let you select operator and bystander measurement positions and assign microphones to each position.
- **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

The following figure shows the Sound Power System with the Sound Pressure Level Measurement Configuration data window active.



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. Values are entered in meters. 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.

**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.



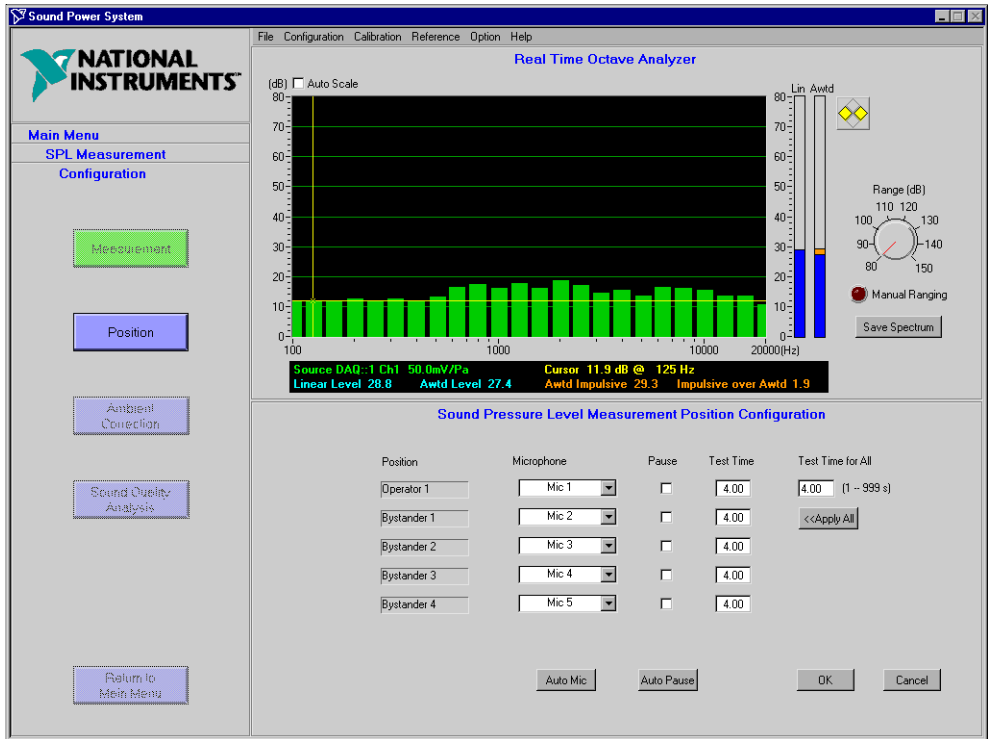
**Note** The Sound Power System supports frequencies from 25 to 20,000 Hz. The **Low Frequency Limit** must be less than the **High Frequency Limit**.

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

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

## Position Configuration

The following figure shows the Sound Power System with the Sound Pressure Level Measurement Position Configuration data window active.



Use this window to assign a configured microphone to each measurement position and to set the measurement parameters. You can access this window in the following ways:

- Select **Configuration»Settings»Sound Pressure Level Measurement»Position** from the main menu bar.
- When the SPL Measurement Configuration flowchart window is active, click on the **Position** button.

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

**Microphone**—Use this list box to assign a microphone you configured in Microphone Configuration to the measurement position. You can click on the **Auto Mic** button to assign microphones sequentially to each position.

**Auto Mic**—Click on this button to automatically assign a microphone to each position in the most logical order (based on the number of microphones configured on the system in the Microphone Configuration and the number of positions configured in the sound pressure level Measurement Configuration). Microphones are assigned in sequential order to each position until all microphones have been used, then the sequence is repeated until all positions have been assigned.



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

**Pause**—Select this check box if you want the measurement sequence to pause after a measurement position. This is useful if you need to move a microphone to a new position between measurements.

**Auto Pause**—Click on this button if you want 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 one operator position and three bystander positions using two microphones, the system would automatically assign a pause to position Bystander 1.

**Test Time**—Enter the length of time (in seconds) you want the system to sample each microphone when determining the  $L_{eq}$  value for each position. Valid values are 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.



**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 configuration file from this routine.

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

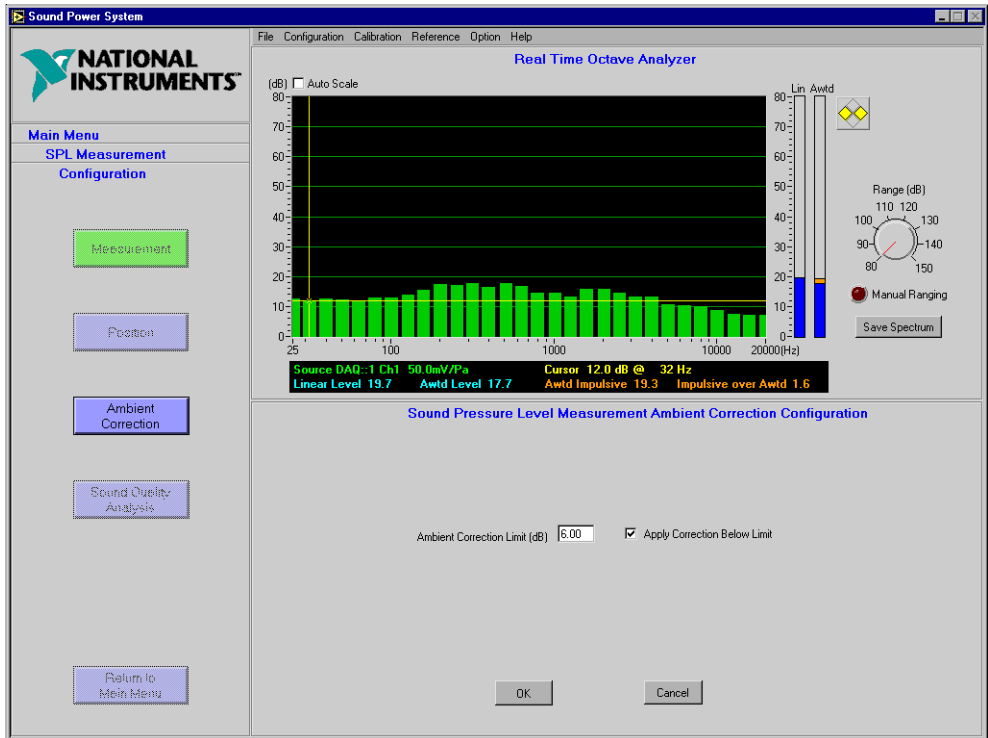
**OK**—Click on this button to accept the values you entered and exit the position configuration.

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



## Ambient Correction Configuration

The following figure shows the Sound Power System with the Sound Pressure Level Measurement Ambient Correction Configuration data window active.



Use this window to configure how ambient noise corrections are applied to the data. You can access this window in the following ways:

- Select **Configuration»Settings»Sound Pressure Level Measurement»Ambient Correction** from the main menu bar.
- When the SPL Measurement Configuration flowchart window is active, click on the **Ambient Correction** button.

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 is set with an initial value of 6.0 dB.

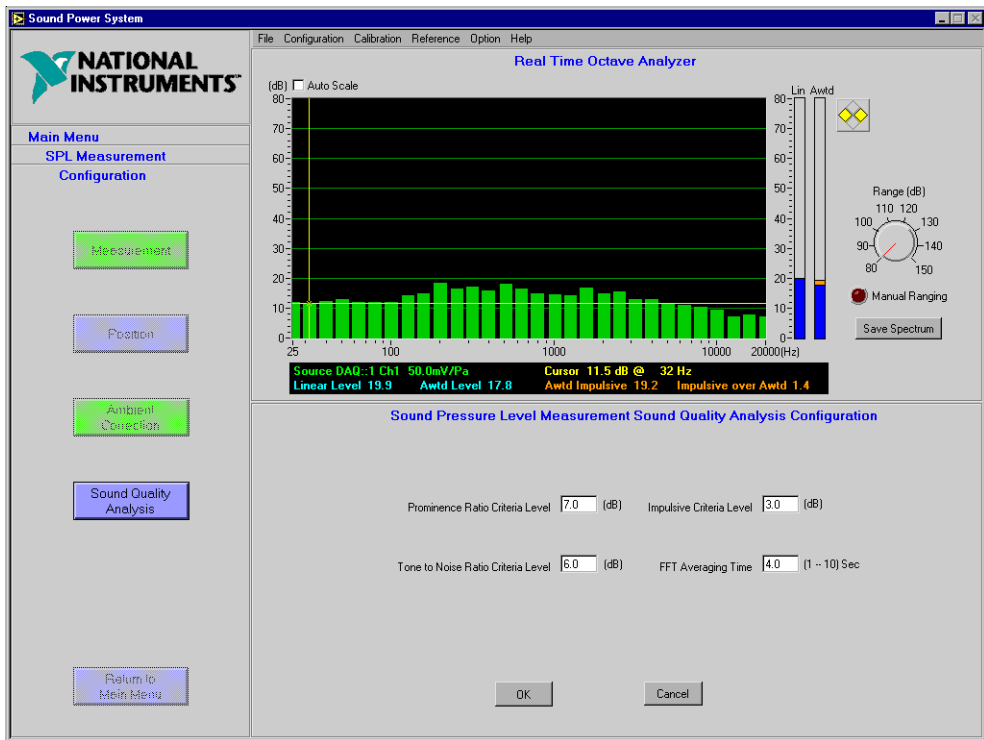
**Apply Correction Below Limit**—When you select this check box, a fixed correction (equal to the correction that would be applied at the correction limit) is applied to the source sound pressure level data if the difference between the source and ambient sound pressure levels is less than the ambient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

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

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

## Sound Quality Analysis Configuration

The following figure shows the Sound Power System with the Sound Pressure Level Measurement Sound Quality Analysis Configuration data window active.



Use this window to configure the analysis options for the sound quality measurements. You can access this window in the following ways:

- Select **Configuration»Settings»Sound Pressure Level Measurement»Sound Quality** from the main menu bar.
- When the SPL Measurement Configuration flowchart window is active, click on the **Sound Quality Analysis** button.

**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 a 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 making the prominent tone analysis. Valid values are from one to ten seconds.

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

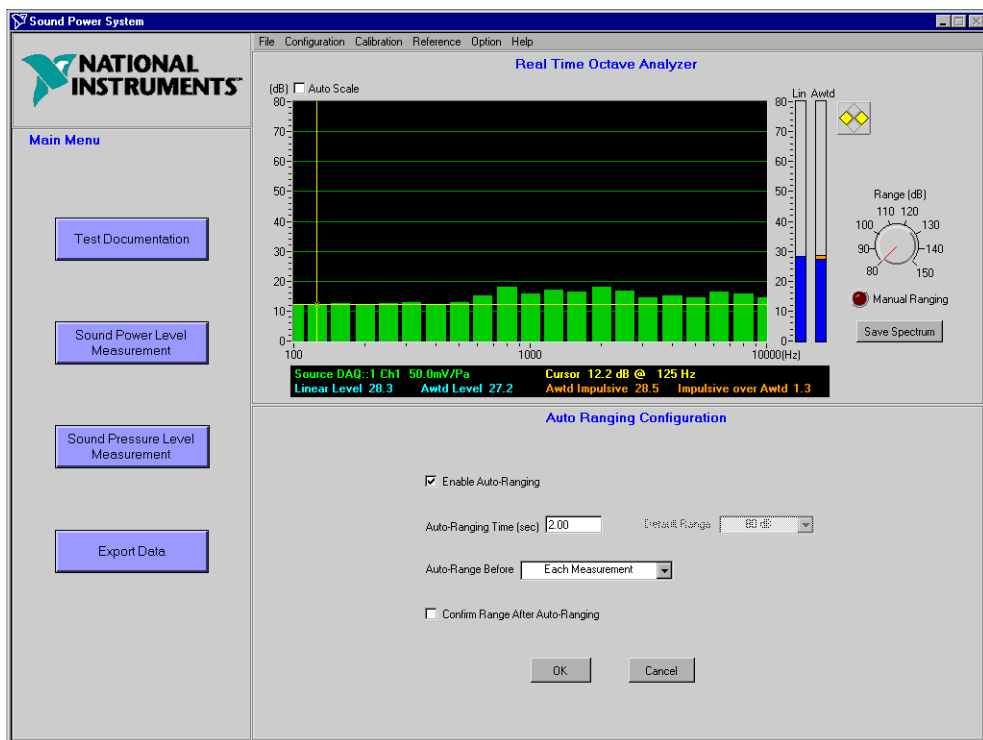
**Cancel**—Click on this button to cancel your entries and exit the sound quality analysis configuration.

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 System 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

The following figure shows the Sound Power System with the Auto Ranging Configuration data window active.



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**—The Sound Power System 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. The default measurement setup file is set with an initial value of always auto-ranging on the first configured microphone when using this option.
- **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.

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

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

# Document Your Test

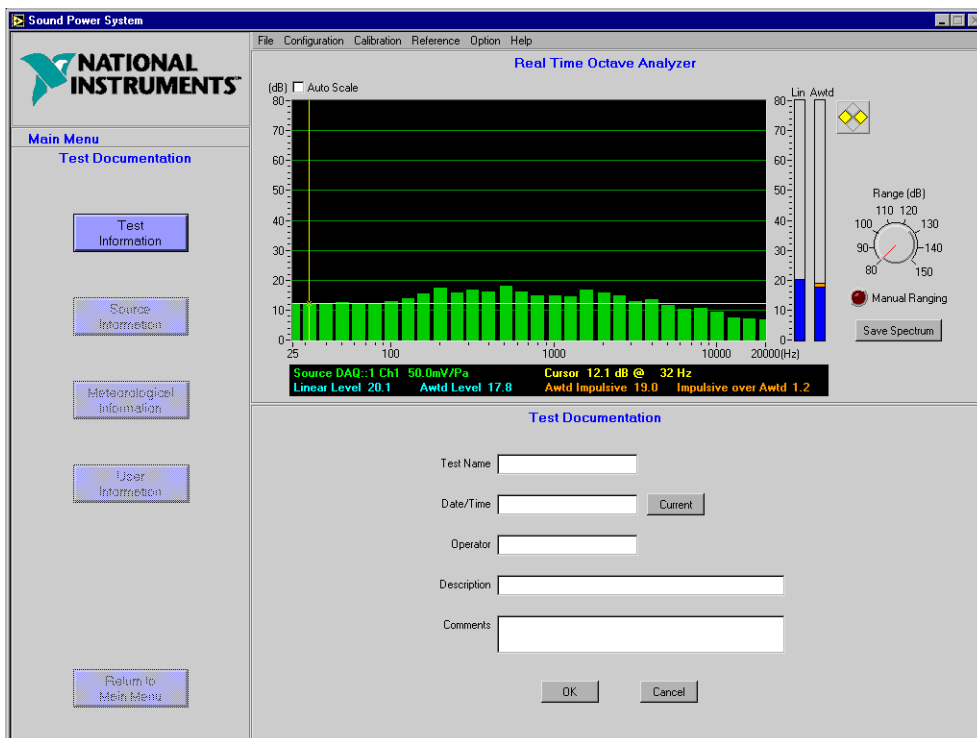
The Sound Power System lets you enter and save documentation on each test you conduct. To access the test documentation routine, select the **Test Documentation** button from the flowchart **Main Menu**. The Test Documentation flowchart appears. The following sections describe the process you use to document the test and equipment under test information.



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

## Test Information

The following figure shows the Sound Power System with the Test Documentation data window active.



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*.

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

**Current**—Click on 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.

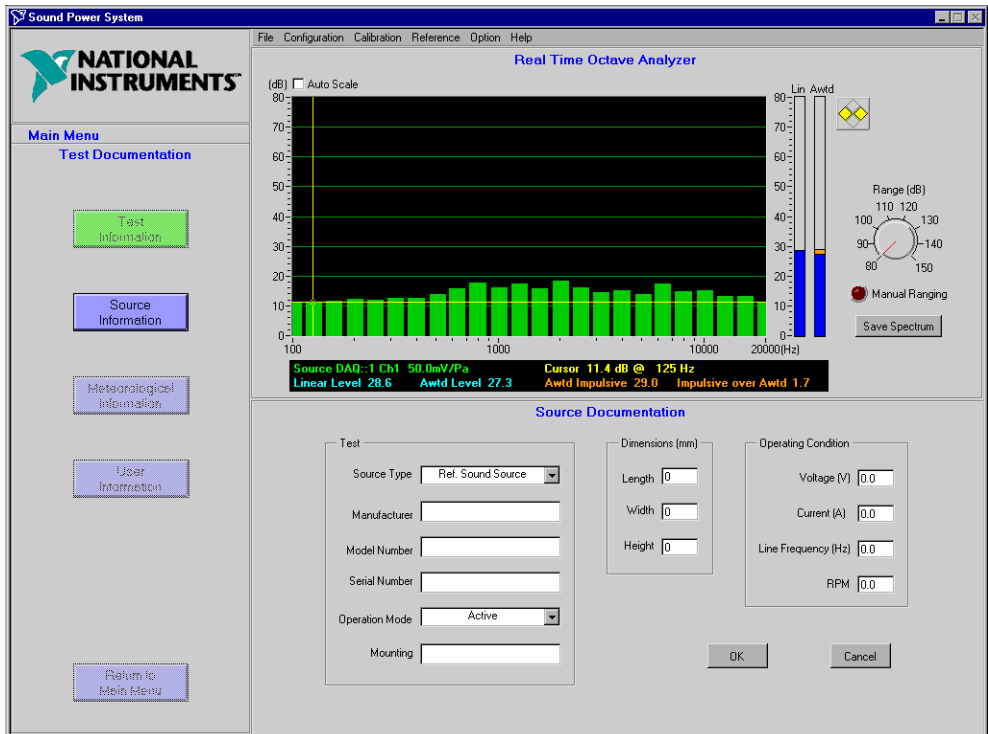
**Comments**—Enter comments about the test.

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

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

# Source Information

The following figure shows the Sound Power System with the Source Documentation data window active.



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. Several common computer and business equipment devices are included in this list box.

**Manufacturer**—Enter the manufacturer of the device being tested.

**Model Number**—Enter the model number of the device being tested.

**Serial Number**—Enter the serial number of the device being tested.



**Operation Mode**—Select the mode that the device was operating in during the test. Several common computer and business equipment operating modes are included in this list box. The software uses the operation mode as part of a suggested file name when you save the file.



**Note** The suggested file name for saving tests is *Test Name\_Operation Mode*.

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

**Dimensions (mm)**—Enter the **Length**, **Width**, and **Height** of the device, in millimeters.

**Voltage (V)**—Enter the voltage at which the device being tested was operated.

**Current (A)**—Enter the current draw for the device being tested.

**Line Frequency (Hz)**—Enter the line frequency at which the device being tested was operated.

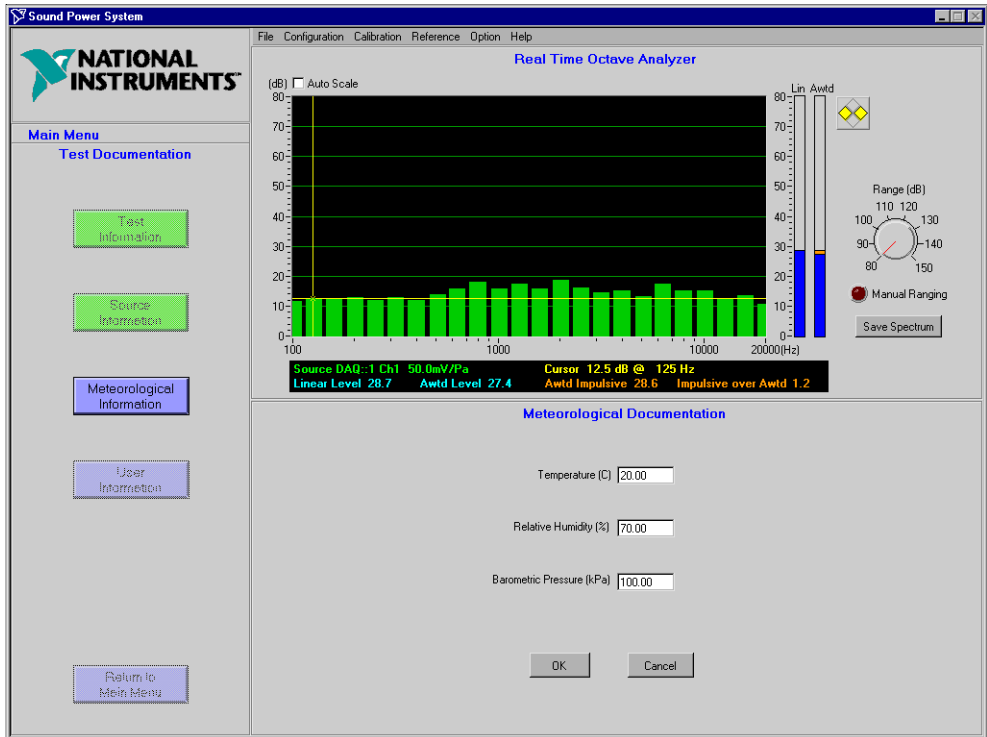
**RPM**—Enter the RPM of the device being tested.

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

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

# Meteorological Information

The following figure shows the Sound Power System with the Meteorological Documentation data window active.



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 (C)**—Enter the temperature (in degrees Celsius) in the test chamber at the time of the test.

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

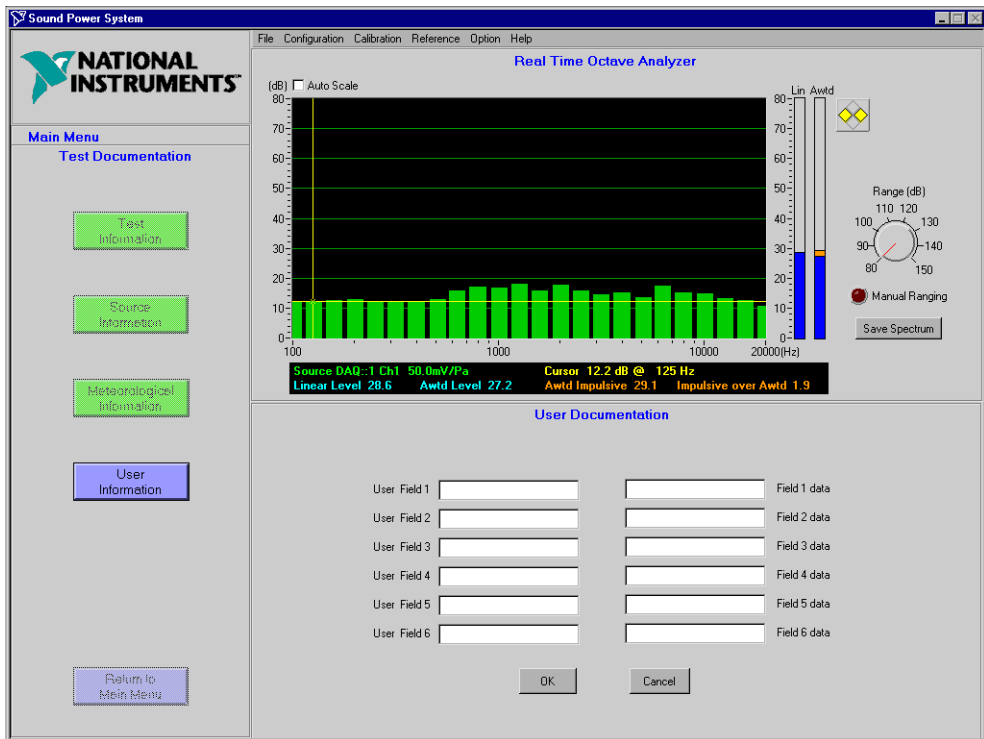
**Barometric Pressure (kPa)**—Enter the barometric pressure (in kPa) at the time of the test.

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

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

## User Information

The following figure shows the Sound Power System with the User Documentation data window active.



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  $n^{\text{th}}$  user field.

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

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

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

## Save Documentation

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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 System native file format.

Test documentation is reloaded into the Sound Power System 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.

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# Calibrate Your Microphones

The Sound Power System 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.

The Sound Power System 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

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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 alpha-numeric 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.

## Configure the Calibration

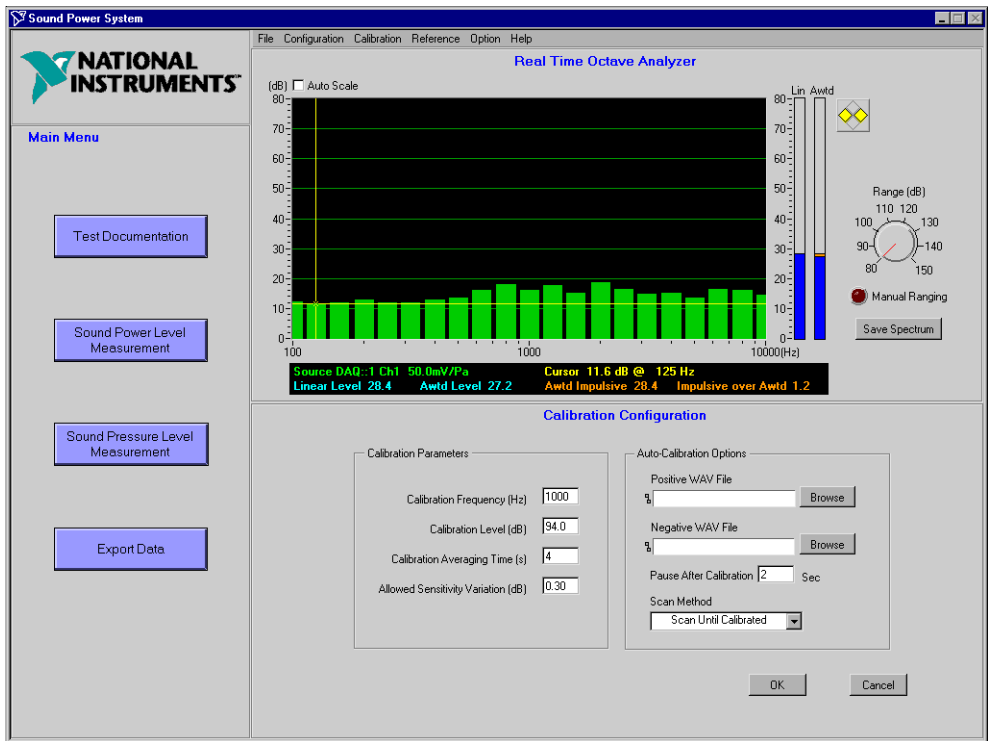
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The following sections describe how to configure your microphone calibration.

You can either load calibration data into the Sound Power System 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 System 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.

The following figure shows the Sound Power System with the Calibration Configuration data window active.



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 on this button to accept the values you entered and exit the calibration configuration.

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



# Microphone Calibration

The following figure shows the Sound Power System 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.

1 Microphone Selection      2 Calibration Configuration      3 Calibration Control Chart Parameters

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 on this button 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 on **Continue** to calibrate the next microphone. This sequence continues through all configured microphones.

**Auto Calibrate**—Click on 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 click on the microphones. 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 configured in the Calibration Configuration 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 Calibration Configuration section.

## 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. The calibration control chart contains the following indicators:

**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 on this button to accept the values you entered and exit the microphone calibration.

**Cancel**—Click on 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 System 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 *Configure the Instruments* and *Configure the Sound Power Level Measurement* section in Chapter 2, *Installation and Configuration*, for more information.

You can either load measurement data into the Sound Power System 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 System 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 on the **Sound Power Level Measurement** button on the main flowchart menu. This launches the PWL Measurement flowchart window, from which you can make measurements.

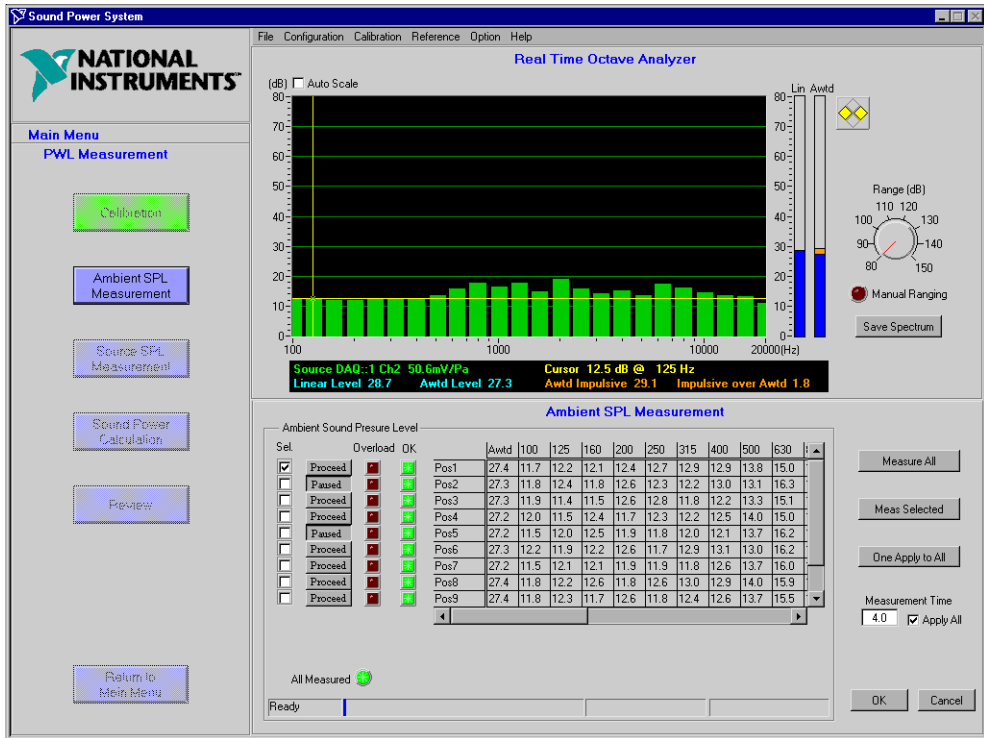
## Calibration

---

Select 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

The following figure shows the Sound Power System with the Ambient SPL Measurement data window active.



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, then clicking on 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.

**Paused/Proceed**—This button determines whether the measurement pauses or proceeds automatically after it takes the measurement at each position. If the button is in **Paused** mode, a prompt will appear before it proceeds to the next measurement. This is useful if you need to move the microphone to a new position between measurements. If the button is in

**Proceed** mode, the measurement automatically proceeds to the next position.

**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.

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

**Meas Selected**—Click on 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.

**One Apply to All**—Click on 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 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 the **Apply All** check box. The measurement configuration 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.

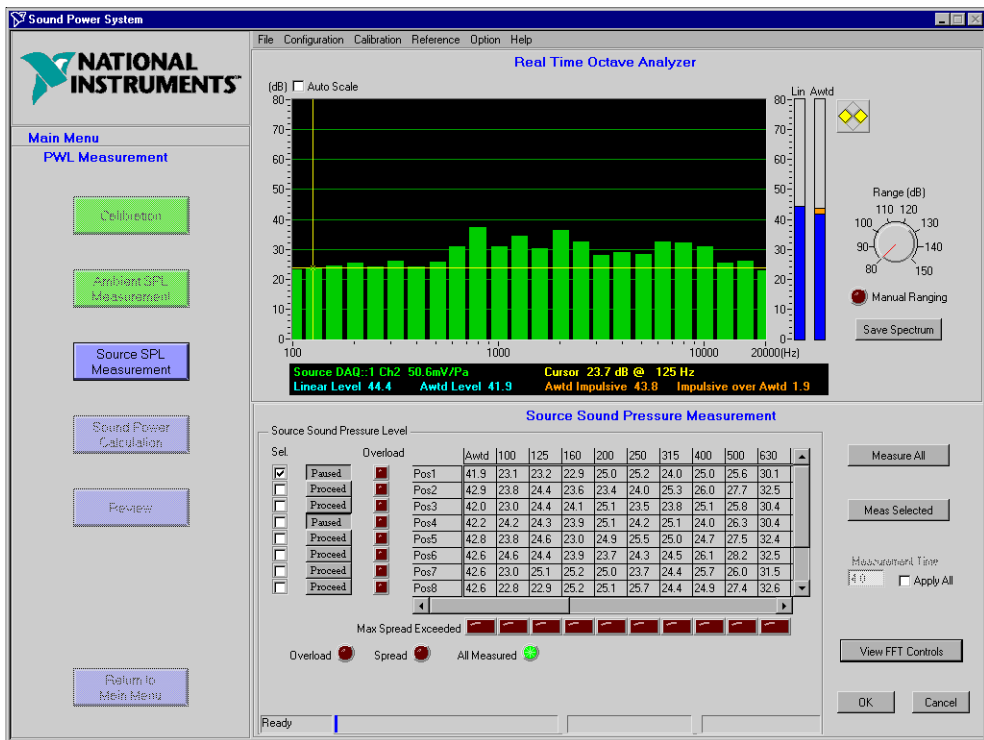
**OK**—Click on this button to accept the data as displayed in the current data table and exit the ambient noise measurement routine.

**Cancel**—Click on 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 noise measurement routine.

The status indicator at the bottom of this data window indicates the current status of the DAQ board. It will either be in the Ready (to acquire data) or Acquire state. When you are acquiring data, a status bar indicates the progress of the measurement.

## Source SPL Measurement

The following figure shows the Sound Power System with the Source Sound Pressure Measurement data window active.



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, then clicking on the **Source SPL Measurement** button.



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

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

**Paused/Proceed**—This button determines whether the measurement pauses or proceeds automatically after it takes the measurement at each position. If the button is in **Paused** mode, a prompt will appear before it proceeds to the next measurement. This is useful if you need to move the microphone to a new position between measurements. If the button is in **Proceed** mode, the measurement automatically proceeds to the next position.

**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.

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

**Measure Selected**—Click on this button if you want 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.

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

**Spread**—If the **Max Spread Exceeded** indicator is lit for any frequency band, this indicator will be lit.

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

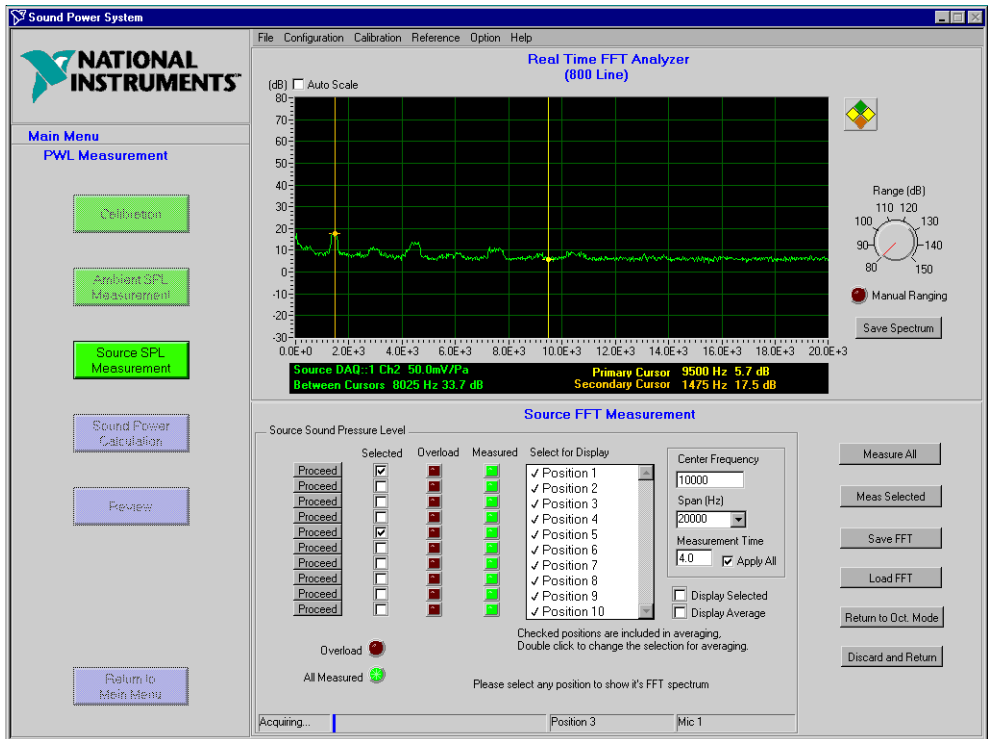
**View FFT Controls**—Click on this button to view the Source FFT Measurement data window, which you can use to conduct measurements and view the results of the FFT positions. For more information, refer to the next section, *FFT Measurement*.

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

**Cancel**—Click on 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.

## FFT Measurement

The following figure shows the Sound Power System with the Source FFT Measurement data window active.



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 on 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. 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.

**Paused/Proceed**—This button determines whether the measurement pauses or proceeds automatically after it takes the measurement at each position. If the button is in **Paused** mode, a prompt will appear before it proceeds to the next measurement. This is useful if you need to move the microphone to a new position between measurements. If the button is in **Proceed** mode, the measurement automatically proceeds to the next position.

**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 on 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 on this button to conduct an FFT at each measurement position, beginning with Position 1 and continuing through the last position. This sequence pauses if the **Paused/Proceed** button is in the **Paused** mode.

**Measure Selected**—Click on 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.

**Save FFT**—Click on 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 on this button to load FFT spectrum 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 independently 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.

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

**Discard and Return**—Click on 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

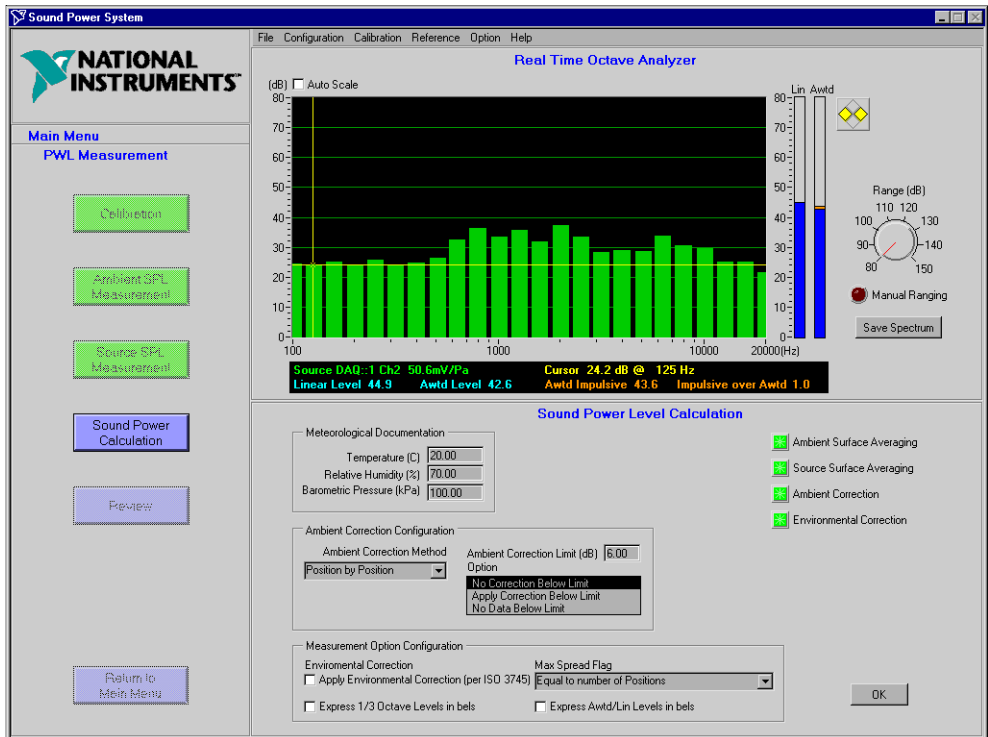
The FFT Sound Pressure Level Measurement routine provides two cursors that you can use to examine the FFT spectra.

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

The following figure shows the Sound Power System with the Sound Power Level Calculation data window active.



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).

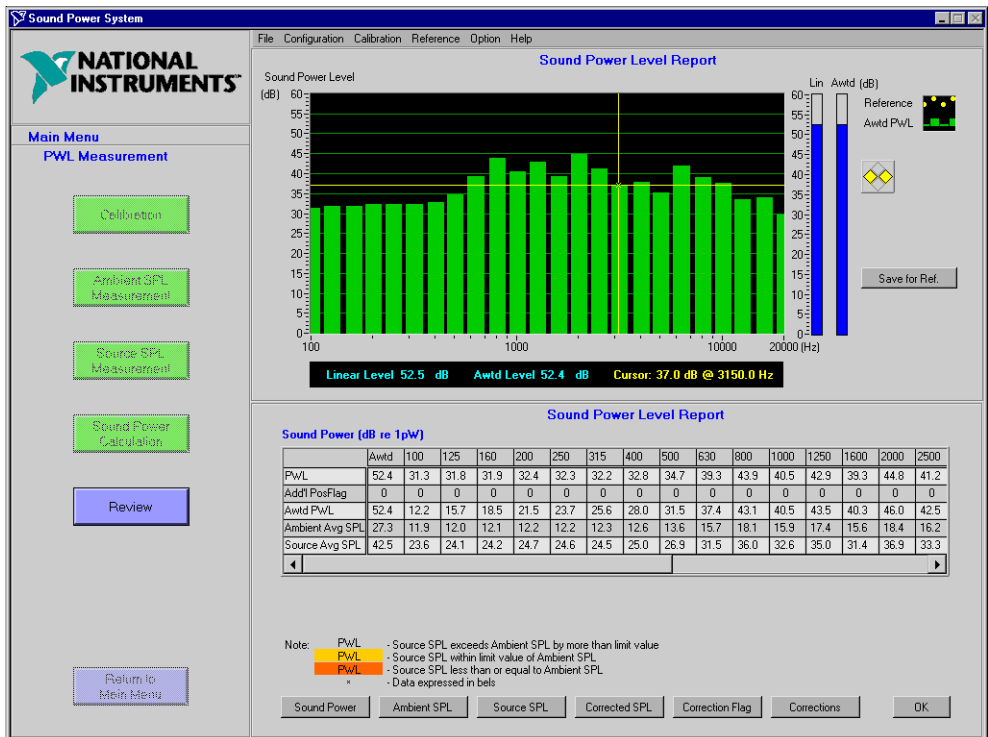
**Express 1/3 Octave Sound Power Levels in bels**—Calculates all 1/3-octave band sound power level results in bels (1 bel = 10 dB).

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

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

## Review

The following figure shows the Sound Power System with the Sound Power Level Report data window active.



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

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

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

**Correction Flag**—Click on 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 on 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 on this button to return to the Sound Power Main Menu.

## Save Measurement

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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 System native file format. Refer to Appendix B, *Program and Data Files*, for a discussion of file formats.

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# 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 make a sound pressure level measurement, make sure you have valid instrument and sound pressure level measurement configuration settings. Refer to the [Configure the Instruments](#) and [Configure the Operator/Bystander Sound Pressure Level Measurement](#) section in Chapter 2, [Installation and Configuration](#), for more information.

You can either load measurement data into the Sound Power System 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 System 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 on the **Sound Pressure Level Measurement** button on the main flowchart menu. This launches the SPL Measurement flowchart window, from which you can make measurements.

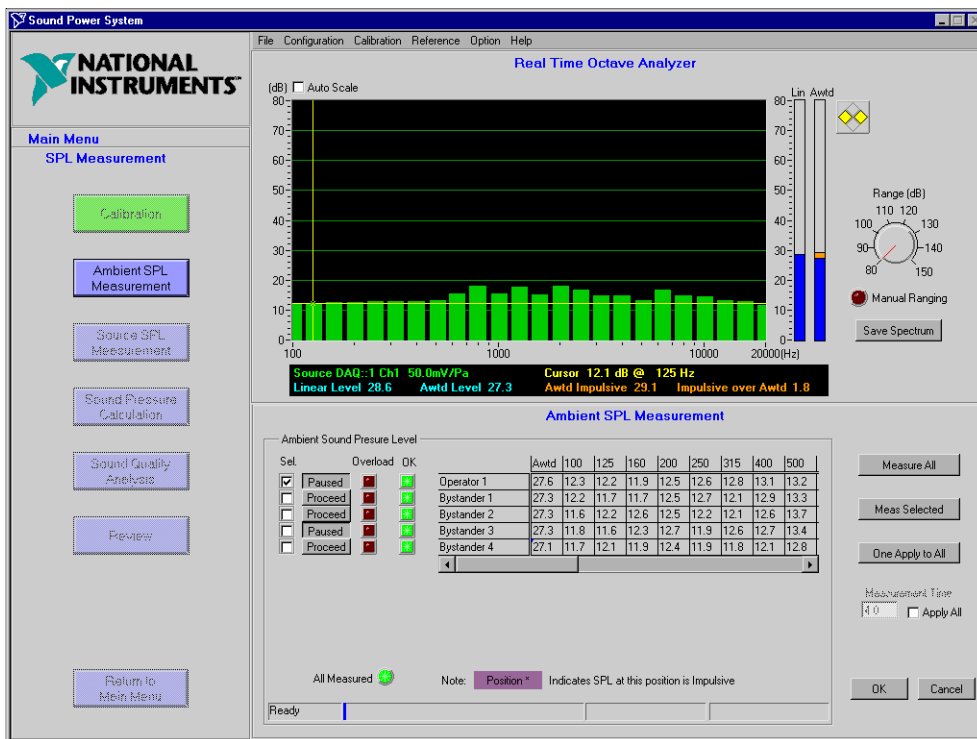
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## Calibration

Select 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

The following figure shows the Sound Power System with the Ambient SPL Measurement data window active.



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 on the **Ambient SPL Measurement** button.



**Note** The ambient sound pressure level measurement routine and controls work exactly 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.

**Paused/Proceed**—This button determines whether the measurement pauses or proceeds automatically after it takes the measurement at each position. If the button is in **Paused** mode, a prompt will appear before it proceeds to the next measurement. This is useful if you need to move the microphone to a new position between measurements. If the button is in **Proceed** mode, the measurement automatically proceeds to the next position.

**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.

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

**Meas Selected**—Click on 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.

**One Apply to All**—Click on 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.

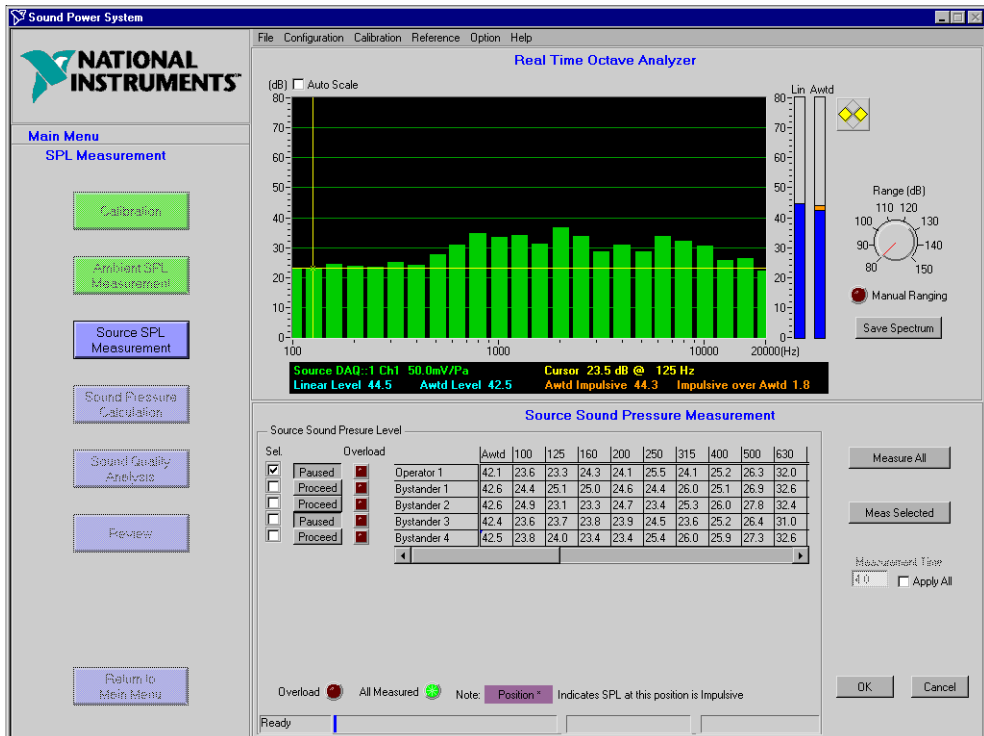
**All Measured**—If the green **All Measured** indicator is lit, there is valid data for each configured position.

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

**Cancel**—Click on 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

The following figure shows the Sound Power System with the Source Sound Pressure Measurement data window active.



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 on 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.

**Paused/Proceed**—This button determines whether the measurement pauses or proceeds automatically after it takes the measurement at each position. If the button is in **Paused** mode, a prompt will appear before it proceeds to the next measurement. This is useful if you need to move the microphone to a new position between measurements. If the button is in **Proceed** mode, the measurement automatically proceeds to the next position.

**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.

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

**Measure Selected**—Click on 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.

**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.

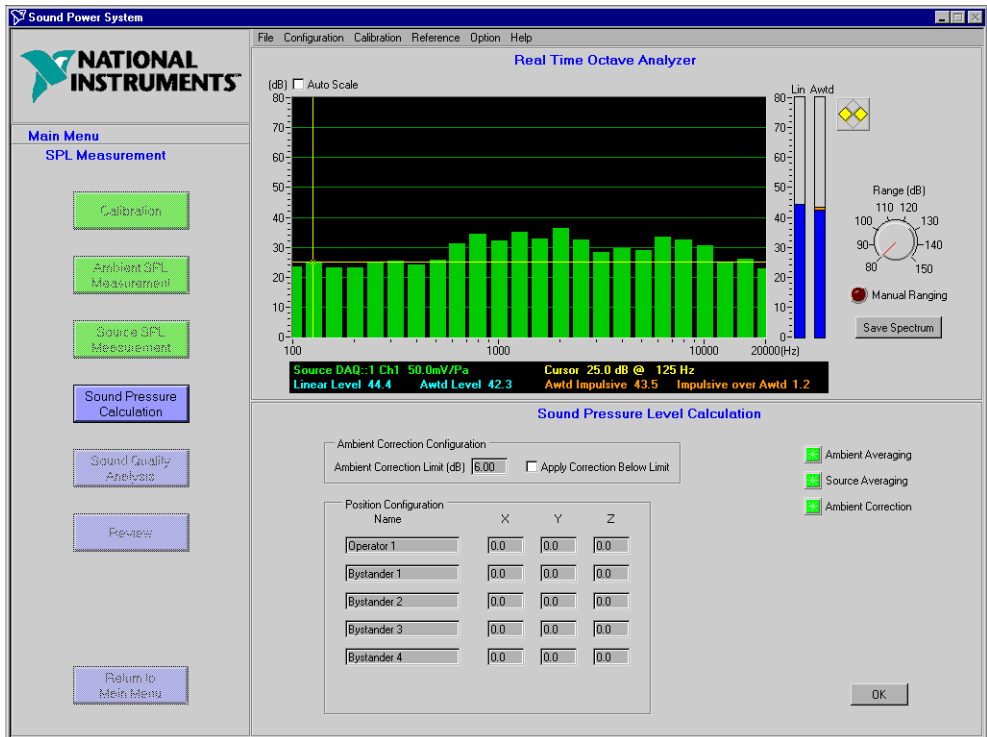
**All Measured** —If the green **All Measured** indicator is lit, there is valid data for each configured position.

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

**Cancel**—Click on 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

The following figure shows the Sound Power System with the Sound Pressure Level Calculation data window active.



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

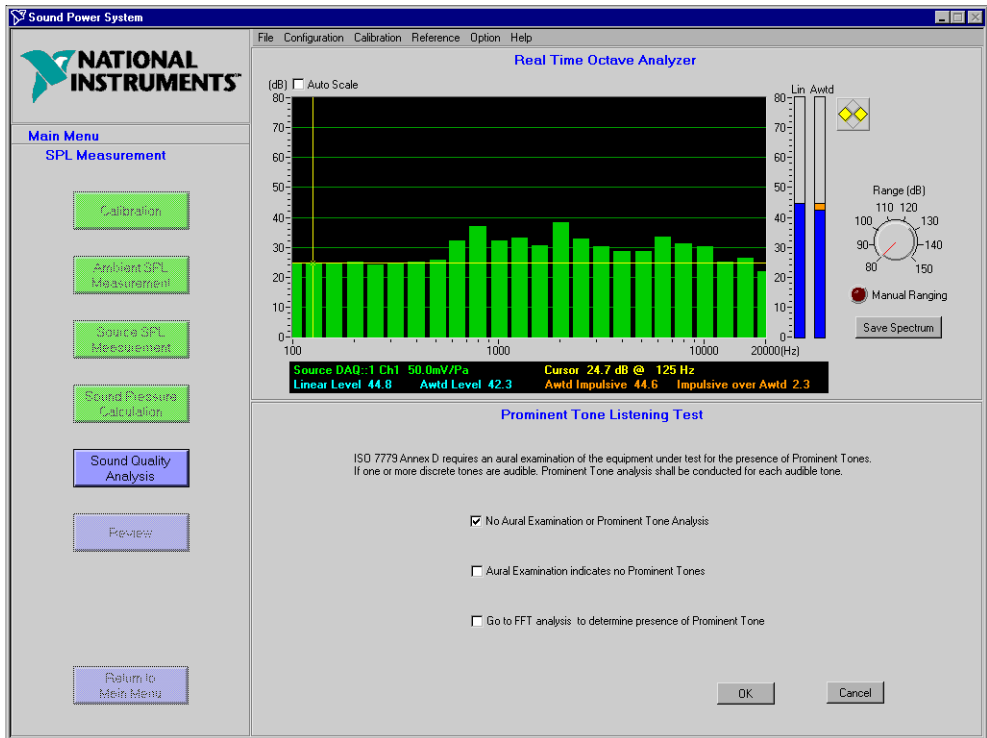
**Name**—Lists selected operator and bystander positions.

**X, Y, Z**—Coordinates for each measurement position.

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

# Sound Quality Analysis

The following figure shows the Sound Power System with the Prominent Tone Listening Test data window active.



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 the presence of prominent tones** 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 Tones**—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 on **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 next section, *Prominent Tone Analysis*.

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

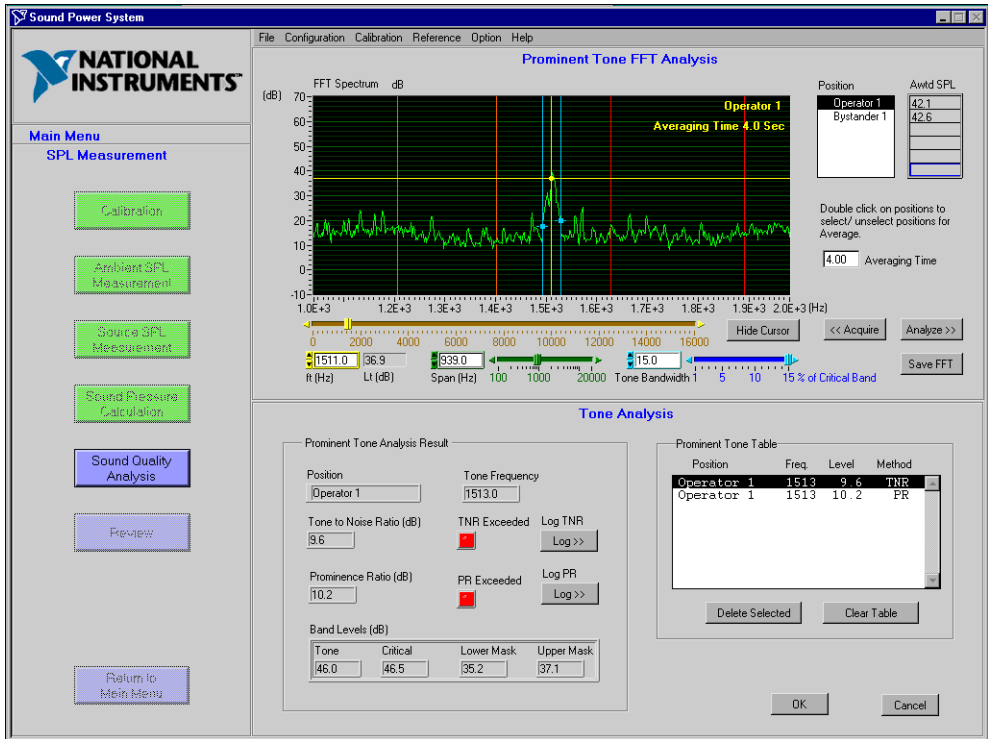
**Cancel**—Click on this button to revert to the previously saved data and exit the prominent tone listening test.



**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

The following figure shows the Sound Power System with the Tone Analysis data window active.



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 Tones** 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.

## 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**—A yellow cursor lets you select the center frequency of a tone to be analyzed. You can move the cursor by clicking on the yellow cursor controls located below the FFT display. Click and drag the slider for course adjustment and use the small 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 tone for tone-to-noise ratio analysis. These cursors are controlled using the **% of critical bandwidth** slider bar below the FFT display. Per ISO 7779, Annex D.5, the maximum bandwidth of these cursors is 15% of the critical bandwidth associated with the tone center frequency.

**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 the analysis control is activated.

**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 on the positions to be included in the average prior to selecting the **Acquire** control.

**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.

**Acquire**—Activating this control causes 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.

**Span (Hz)**—The FFT spectrum can be zoomed around the current cursor location to a frequency range selected by using the **Span** control or slider. This control lets you select of the frequency range (in Hz) shown on the FFT display.

**Tone Bandwidth**—The bandwidth of the energy to be included in the tone level during tone-to-noise ratio analysis is controlled using the **Tone Bandwidth** control or slider. The indicator displays the current bandwidth in terms of the percentage of the critical band. The blue cursors display the current bandwidth. The cursors can be moved from 1% to 15% of the critical frequency of the currently selected tone.

**Hide Cursors**—Click on 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.

**Save FFT**—Click on 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 location of the tone center frequency cursor.

**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 control that allows the analysis results to be logged to the prominent tone table. Click on this button to write the results of the selected analysis method to the prominent tone table.

**Band Levels (dB)**—The **Band Levels** 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.

## Prominent Tone Table

To the right of the prominent tone analysis data window is the prominent tone table, where the logged results are displayed. It contains two controls:

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

**Clear Table**—Lets you delete all logged tones.

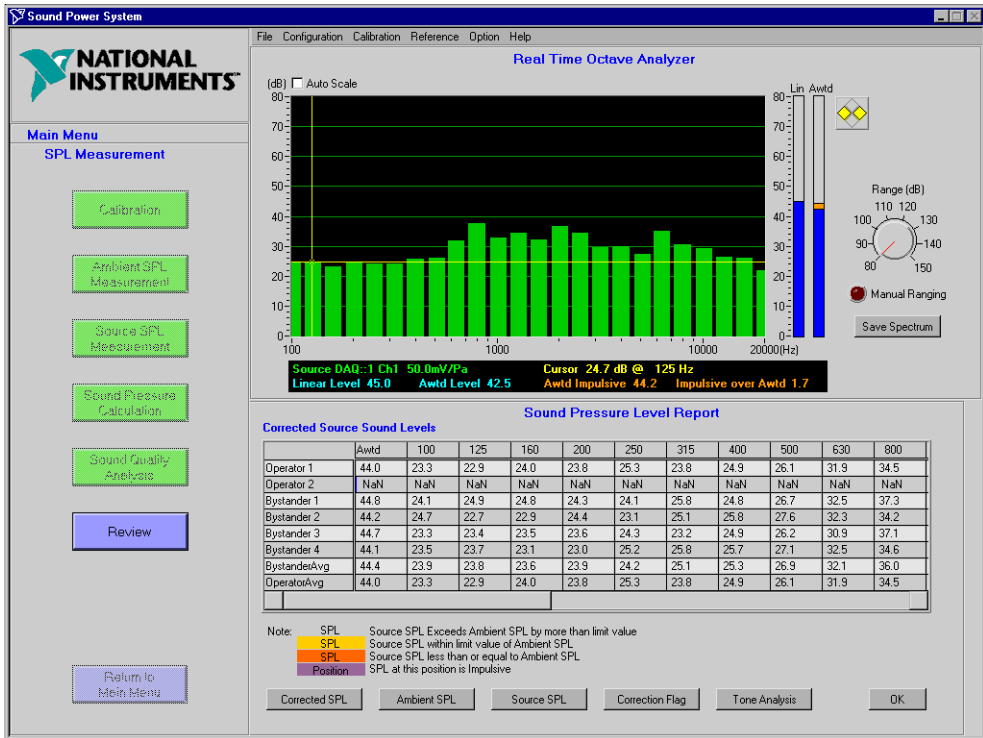
**OK**—Click on this button to accept the values and return to the main SPL Measurement flowchart.

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



# Review

The following figure shows the Sound Power System with the Sound Pressure Level Report data window active.



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

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

**Correction Flag**—Click on 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 on this button to display the prominent tone test results.

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

## Save Measurement

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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 System native file format. Refer to Appendix B, *Program and Data Files*, for a discussion of file formats.

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# Exporting Data

The Sound Power System includes a routine that lets you export test data into pre-formatted Microsoft Excel workbook template files. These workbook template files contain a series worksheets for each section of the test information. You can also add additional worksheets to these template workbook files. These additional worksheets can be pre-configured and pre-linked to the data export worksheets, providing an efficient method for setting up custom data analysis templates.

The structure of workbook template files is documented in Appendix B, *Program and Data Files*.

You can access the export routine by clicking on the **Export Data** button in the **Main** flowchart window.

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



**Note** The Sound Power System comes with an example workbook template file called `Report Template.xls`. This workbook template file contains all necessary worksheets for Sound Power System export data and contains several user worksheets that create certificate-like test reports for sound power and sound pressure measurement data. This workbook template file can be used to create other custom template files.

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

The routine provides a file dialog box that prompts you to confirm or enter a filename for the exported data file. By default, the routine suggests a file name of *Test Name\_Operating Mode*, where test name and operating mode come from the Test Documentation (as configured in Chapter 3, *Document Your Test*). You can accept this name or enter a new file name.

Click on **Save** to start the export. A dialog box appears to inform you of the process. A check box option lets you leave Excel open after the data is exported.

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# 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.

Reference spectra can be entered into the system in the following ways:

- 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.

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

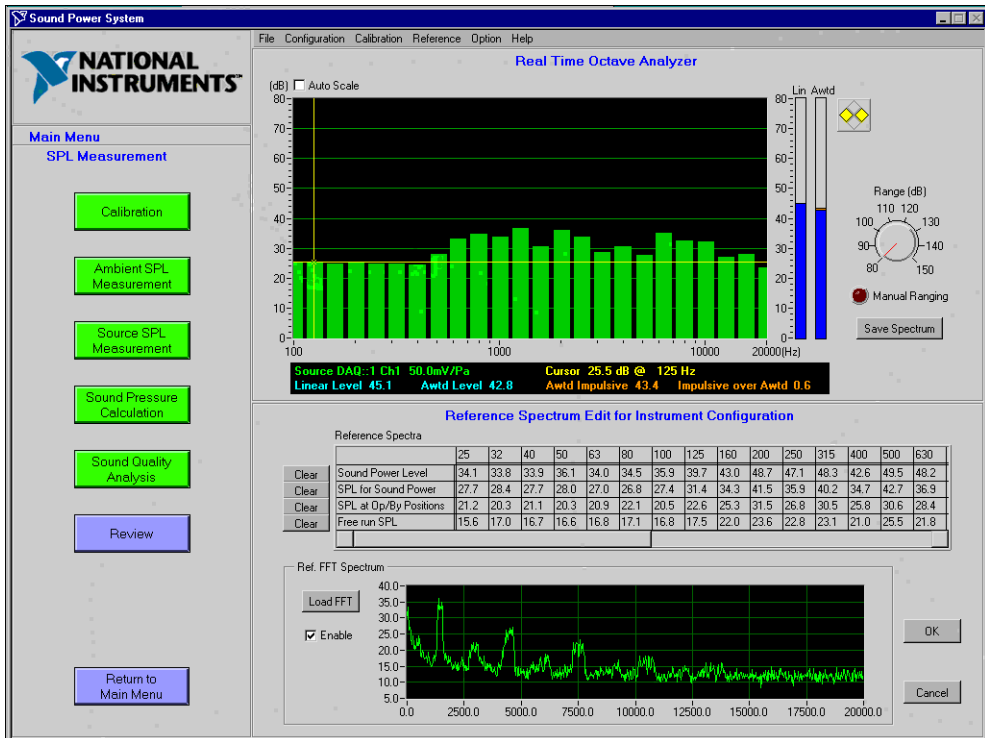
# Reference Spectrum Configuration

You can either load reference spectrum information into the Sound Power System 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 System 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**.

The following figure shows the Sound Power System with the Reference Spectrum Edit for Instrument Configuration data window active.



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 on this button, all cells are set to “NaN” (Not a Number) and no reference spectrum is displayed.

**Load FFT**—Click on 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 on this button to accept the values you entered and exit the reference spectrum configuration.

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

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# Configuration Concepts, Protocols, and Calculations

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## Instrument and Measurement Configuration Concepts

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The Sound Power System 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. The Sound Power System 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.

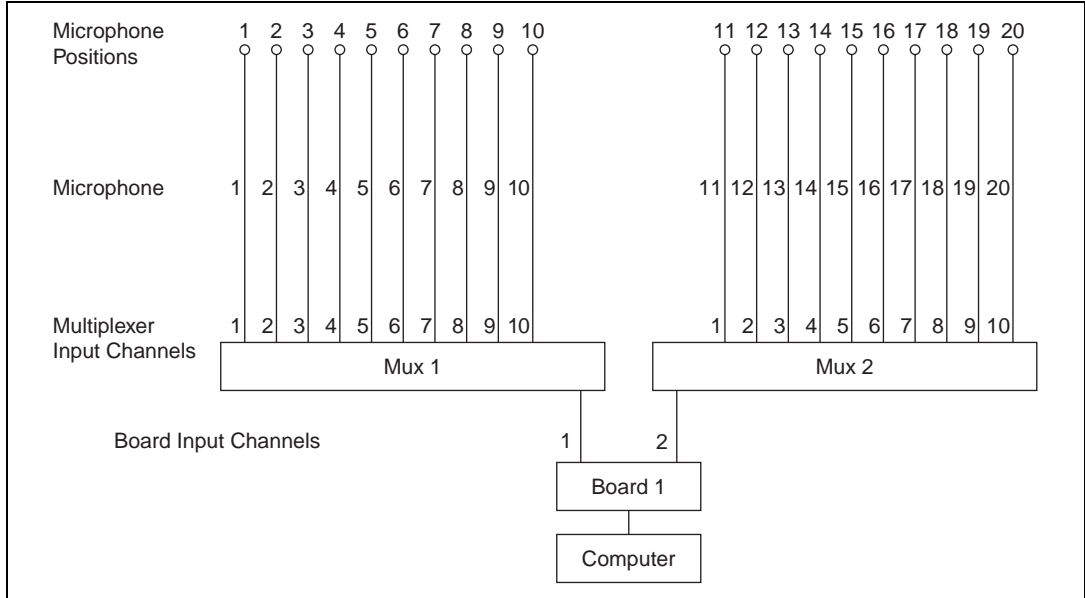
The following table shows an example of how microphones might be assigned.

**Table A-1.** Microphone Assignment Logic

<b>Position Number</b>	<b>Microphone Number</b>	<b>Multiplexer Number</b>	<b>Multiplexer Channel Number</b>	<b>Board Number</b>	<b>Board Channel Number</b>
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 shows 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 ten-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 the Sound Power System uses to calculate the ambient correction.

## Position-by-Position Corrections

This table 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><b>Case: SourceSPL(f,n) – AmbientSPL(f,n) ≥ Correction Limit</b></p> $CorrectedSPL(f,n) = 10 * \log (10^{SourceSPL(f,n)/10} - 10^{AmbientSPL(f,n)/10})$ <p><b>Case: SourceSPL(f,n) – Ambient SPL(f,n) &lt; Correction Limit</b></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><b>Case: SourceSPL(f,n) – AmbientSPL(f,n) ≥ Correction Limit</b></p> $AmbientStatusFlag(f,n) = 0$ <p><b>Case: Correction Limit &gt; SourceSPL(f,n) – AmbientSPL(f,n) &gt; 0</b></p> $AmbientStatusFlag(f,n) = 1$ <p><b>Case: SourceSPL(f,n) – AmbientSPL(f,n) ≤ 0</b></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><b>Case: SurfaceAvgSourceSPL(f) – SurfaceAvgAmbientSPL(f) ≥ Correction Limit</b></p> $\text{SurfaceAvgAmbientStatusFlag}(f) = 0$ <p><b>Case: Correction Limit &gt; SurfaceAvgSourceSPL(f) – SurfaceAvgAmbientSPL(f) &lt; 0</b></p> $\text{SurfaceAvgAmbientStatusFlag}(f) = 1$ <p><b>Case: SurfaceAvgSource(f) – SurfaceAvgAmbient(f) ≤ 0</b></p> $\text{SurfaceAvgAmbientStatusFlag}(f) = 2$
Calculate sound power	<p><b>Case: Apply Meteorological Correction = True</b></p> $\text{SoundPower}(f) = \text{SurfaceAvgCorrectedSoundPressure}(f) + 10 * \log(\text{TotSurfaceArea}) - 10 * \log[(293 / (273 + \text{Temperature}))^{0.5}] * (\text{BarometricPressure} / 1000)$ <p><b>Case: Apply Meteorological Correction = False</b></p> $\text{SoundPower}(f) = \text{SurfaceAvgCorrectedSoundPressure}(f) + 10 * \log(\text{TotalSurfaceArea})$
<p>Where</p> <p><math>n</math> = measurement position  <math>f</math> = 1/3-octave band center frequency  Total Surface Area in square meters</p> <p>Barometric Pressure in millibars  Temperature in °C</p>	

## Surface Average Corrections

This table 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><b>Case: <math>SourceSPL(f,n) - AmbientSPL(f,n) \geq Correction\ Limit</math></b></p> $AmbientStatusFlag(f,n) = 0$ <p><b>Case: <math>Correction\ Limit &gt; SourceSPL(f,n) - AmbientSPL(f,n) &gt; 0</math></b></p> $AmbientStatusFlag(f,n) = 1$ <p><b>Case: <math>SourceSPL(f,n) - AmbientSPL(f,n) \leq 0</math></b></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><b>Case: <math>SurfaceAvgSourceSPL(f) - SurfaceAvgAmbientSPL(f) \geq Correction\ Limit</math></b></p> $CorrectedSurfaceAvgSourceSPL(f) - 10 * \log ( 10^{SurfaceAvgSourceSPL(f)/10} - 10^{SurfaceAvgAmbientSPL(f)/10} )$ <p><b>Case: <math>SurfaceAvgSourceSPL(f) - SurfaceAvgAmbientSPL(f) &lt; Correction\ Limit</math></b></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><b>Case: SurfaceAvgSourceSPL(f) – SurfaceAvgAmbientSPL(f) ≥ Correction Limit</b></p> $\text{SurfaceAvgAmbientStatusFlag}(f) = 0$ <p><b>Case: Correction Limit &gt; SurfaceAvgSourceSPL(f) – SurfaceAvgAmbientSPL(f) &lt; 0</b></p> $\text{SurfaceAvgAmbientStatusFlag}(f) = 1$ <p><b>Case: SurfaceAvgSourceSPL(f) – SurfaceAvgAmbientSPL(f) ≤ 0</b></p> $\text{SurfaceAvgAmbientStatusFlag}(f) = 2$
Calculate sound power	<p><b>Case: Apply Meteorological Correction = True</b></p> $\text{SoundPower}(f) = \text{SurfaceAvgCorrectedSoundPressure}(f) + 10 * \log(\text{TotSurfaceArea}) - 10 * \log[(293 / (273 + \text{Temperature}))^{0.5} * (\text{BarometricPressure} / 1000)]$ <p><b>Case: Apply Meteorological Correction = False</b></p> $\text{SoundPower}(f) = \text{SurfaceAvgCorrectedSoundPressure}(f) + 10 * \log(\text{TotalSurfaceArea})$
<p>Where</p> <p><math>n</math> = measurement position  <math>f</math> = 1/3-octave band center frequency  Total Surface Area in square meters</p> <p>Barometric Pressure in millibars  Temperature in °C</p>	

## Sound Quality Analysis Calculations

The Sound Power System 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**—The Sound Power System 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

This table describes the calculations performed at each step in the prominent tone analysis routine.

**Table A-4.** Prominent Tone Logic and Calculations

Action	Calculations
Bracket possible tone (Tone bandwidth control)	Upper Cursor Position = $f_{tu}$ ; <b>tone upper frequency limit</b> Lower Cursor Position = $f_{tl}$ ; <b>tone lower frequency limit</b>
Analyze possible tone (Analyze control)	Tone Center Frequency = $f_t$
Calculate critical and masking bands for possible tone being analyzed	$\Delta f_c = 25 + 75 * (1 + 1.4(ft/1000)^2)^{0.69}$ ; <b>critical Bandwidth</b> $f_{cl} = -\Delta f_c / 2 + \text{sqrt}(\Delta f_c^2 + 4 * f_t^2) / 2$ ; <b>critical band lower freq limit</b> $f_{cu} = f_{cl} + \Delta f_c$ <b>critical band upper freq limit</b> $f_{mll} = f_{cl}^2 / f_{cu}$ <b>masking noise, low band, lower freq limit</b> $f_{mlu} = f_{cl}$ <b>masking noise, low band, upper freq limit</b> $f_{mul} = f_{cu}$ <b>masking noise, upper band, low freq limit</b> $f_{muu} = f_{cu}^2 / f_{cl}$ <b>masking noise, upper band, upper freq limit</b>

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

Action	Calculations
Calculate energy in tone and critical bands	$W_t$ = Energy sum between $f_{tl}$ and $f_{tu}$ $W_c$ = 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 $f_{muu}$ $W_i = \sum 10^{(SPL_i/10)}$
Calculate tone ratios	$TNR = 10\log(W_t) - 10\log(W_c - W_t)$ ; <b>Tone to Noise Ratio</b> $PR = 10\log(W_c / ((W_{ml} + W_{mu}) / 2))$
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. Logic that is unique to the sound pressure routine is:

- 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

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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

The Sound Power System creates and uses several types of files, as defined in the following table.

**Table B-1.** File Types Used by Sound Power System

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

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

Type of File	Extension	Default Location	Default File Name
Microphone Sensitivity	.xls	Sound Power\Data\ Microphone	<i>Microphone Sensitivity Template</i>
Data Export	.xls	Sound Power\Data\ Measurement	<i>test name_operating mode</i>
FFT Reference Spectrum	.txt	Sound Power\Data\ Measurement	<i>Ref_FFT_Default</i>
FFT Data	.txt	Sound Power\Data\ Measurement	Not applicable
Excel Export Template	.xls	Sound Power\Data\ Template	<i>Report Template</i>

The Sound Power System 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 the Sound Power System, 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 files are in the native file format for the Sound Power System. These files are created or read from within the Sound Power System. 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 is used for data export files and microphone sensitivity files. The Sound Power System writes, but does not read, .xls data export files. The Sound Power System reads, but does not write, .xls microphone sensitivity files.

# Data Export Files

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The Sound Power System 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

The Sound Power System 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 format for the workbook is as follows:

**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. The Sound Power System lets you designate the name of the template file into which the test data is exported.

The Report Template workbook provided with the Sound Power System 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** The Sound Power System 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

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

### Worksheet Contents

You can import microphone parameters into the Sound Power System 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 the Sound Power System (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 a 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 the Sound Power System.



**Note** The sensitivity offset of the microphone is used in conjunction with the quality assurance feature in the Sound Power System 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**—The Sound Power System 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

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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.

The Sound Power System supports two types of instrument configuration files:

- **Default**—When the Sound Power System 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 the Sound Power System.

## Measurement Configuration Files

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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, the Sound Power System supports two types of measurement configuration files:

- **Default**—When the Sound Power System 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 the Sound Power System.

## Reference Spectrum Files

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The Sound Power System 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.

Reference spectrum files can be created for the following:

**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.

Reference spectra can be created using controls on the graphic window or can be entered into a data table by selecting **Reference»Edit Spectrum** (with the exception of the FFT reference spectrum).

# Report Template Files

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The sample reports are provided with the Sound Power System 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:** *Your Laboratory*  
**ISO 7779 Sound Power Test Report**  
**Report Date:** *Today's Date*

## Test Information

**Test Name** – *Test Name Data*  
**Test Date** – *Date/Time Data*  
**Test Operator** – *Test Operator Data*  
**Test Description** – *Test Description Data that can be more than one line long.*  
**Comments** – *Comment Data field that can be more than one line long.*

## Source Information

**Source Type** – *Source Type Data*  
**Manufacturer** – *Manufacturer Data*  
**Model Number** – *Model Number Data*  
**Serial Number** – *Serial Number Data*  
**Operating Mode** – *Operating Mode Data*  
**Mounting** – *Mounting Data*  
**Dimensions** ( $l \times w \times h$  mm) – *xxxx × xxx × xxx*  
**Voltage** (v) – *Voltage Data*  
**Current** (A) – *Current Data*  
**Line Freq** (Hz) – *LF Data*   **RPM** – *RPM Data*

## Meteorological Information

**Temperature** (C) – *Temperature Data*  
**Humidity** (%) – *Relative Humidity Data*  
**Pressure** (kPa) – *Pressure Data*

## User Information

**User Field Name 1** – *User Field Data 1*  
**User Field Name 2** – *User Field Data 2*  
**User Field Name 3** – *User Field Data 3*  
**User Field Name 4** – *User Field Data 4*  
**User Field Name 5** – *User Field Data 5*  
**User Field Name 6** – *User Field Data 6*

## 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  $1 \times 10^{-12}$  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*





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# Supported Drivers

## Additional Hardware Supported by the Sound Power System

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The Sound Power System provides drivers for several hardware devices commonly used in acoustics laboratories that make computer and business equipment noise emission measurements. The Sound Power System includes drivers that support the following microphone multiplexers:

- 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.



**Note** The Brüel & Kjaer 2811 multiplexer driver works well with newer Brüel & Kjaer 2811 units. However, some problems have been noted in controlling Brüel & Kjaer 2811 devices with six-digit serial numbers. Older Brüel & Kjaer devices may use communication protocols that are not compatible with the Sound Power System drivers.

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

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# Technical Support Resources

This appendix describes the comprehensive resources available to you in the Technical Support section of the National Instruments Web site and provides technical support telephone numbers for you to use if you have trouble connecting to our Web site or if you do not have internet access.

## NI Web Support

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To provide you with immediate answers and solutions 24 hours a day, 365 days a year, National Instruments maintains extensive online technical support resources. They are available to you at no cost, are updated daily, and can be found in the Technical Support section of our Web site at [www.ni.com/support](http://www.ni.com/support)

### Online Problem-Solving and Diagnostic Resources

- **KnowledgeBase**—A searchable database containing thousands of frequently asked questions (FAQs) and their corresponding answers or solutions, including special sections devoted to our newest products. The database is updated daily in response to new customer experiences and feedback.
- **Troubleshooting Wizards**—Step-by-step guides lead you through common problems and answer questions about our entire product line. Wizards include screen shots that illustrate the steps being described and provide detailed information ranging from simple getting started instructions to advanced topics.
- **Product Manuals**—A comprehensive, searchable library of the latest editions of National Instruments hardware and software product manuals.
- **Hardware Reference Database**—A searchable database containing brief hardware descriptions, mechanical drawings, and helpful images of jumper settings and connector pinouts.
- **Application Notes**—A library with more than 100 short papers addressing specific topics such as creating and calling DLLs, developing your own instrument driver software, and porting applications between platforms and operating systems.

## Software-Related Resources

- **Instrument Driver Network**—A library with hundreds of instrument drivers for control of standalone instruments via GPIB, VXI, or serial interfaces. You also can submit a request for a particular instrument driver if it does not already appear in the library.
- **Example Programs Database**—A database with numerous, non-shipping example programs for National Instruments programming environments. You can use them to complement the example programs that are already included with National Instruments products.
- **Software Library**—A library with updates and patches to application software, links to the latest versions of driver software for National Instruments hardware products, and utility routines.

## Worldwide Support

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National Instruments has offices located around the globe. Many branch offices maintain a Web site to provide information on local services. You can access these Web sites from [www.ni.com/worldwide](http://www.ni.com/worldwide)

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Switzerland 056 200 51 51, Taiwan 02 2528 7227,  
United Kingdom 01635 523545

# Glossary

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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 the measurement that better detects the energy in impulsive sounds (like a dot matrix printer would make).

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.

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
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## **V**

V	volt
VI	virtual instrument

## **W**

.wav	An industry standard format for sound files.
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