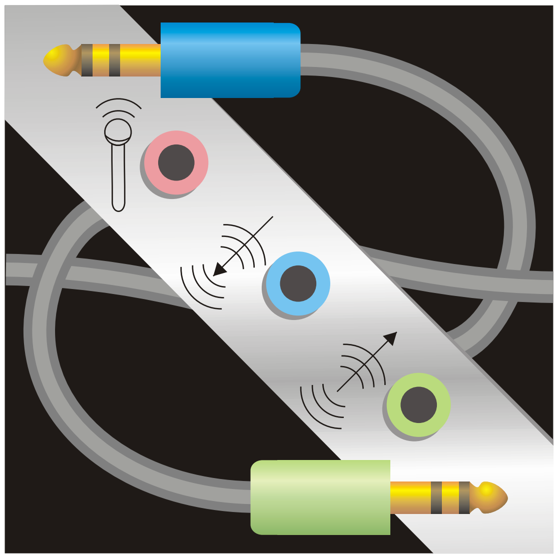
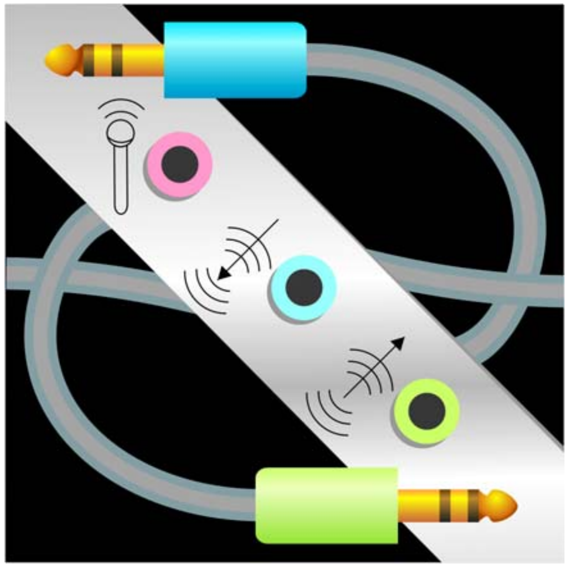
APP-2010

PC Audio Test

USER'S MANUAL



PC Audio Test User's Manual



Installation and Operation of

APP-2010
PC Audio Test

Audio precision®

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Chapter 1

Introduction

Welcome to Audio Precision's APP-2010, PC Audio Test™. Included with the application software CD-ROM is this user's manual and a set of four cables designed to provide an optimal interface between a PC audio device and your Audio Precision measurement instrument.

This chapter provides an overview of the capabilities and requirements of PC Audio Test and gives a quick tour of its features. Go to Chapter 2, **Getting Ready**, to install PC Audio Test and begin configuring your system for testing.

Refer to the **Quick Start Guide** (included with the PC Audio Test materials and as a PDF file on the CD-ROM) as you familiarize yourself with the application. We also recommend reading the AES convention paper *Testing Challenges in Personal Computer Audio Devices* referred to on page 122 and included as a PDF on the CD-ROM.

Overview

PC Audio Test is a software application for use with select Audio Precision measurement instruments. It provides quick, accurate, detailed measurements of the audio performance of a PC sound device such as a sound card or a motherboard implementation of a sound device. The sound device under test (DUT) must be part of a personal computer system using Microsoft Windows as the operating system.

PC Audio Test is comprised of a suite of tests that can completely characterize a PC sound device, including level, phase, distortion, noise, crosstalk and response measurements for the device's input, output, recording and playback functions in both the analog and digital domains. The PC Audio Test measurements include all the tests required to satisfy the WHQL PC-2001 standard.

In its local configuration PC Audio Test performs measurements on the sound device installed in the PC running the Audio Precision control software. See Figure 1 for a system diagram in local configuration. A remote configuration enables PC Audio Test to perform the measurements on a PC audio device

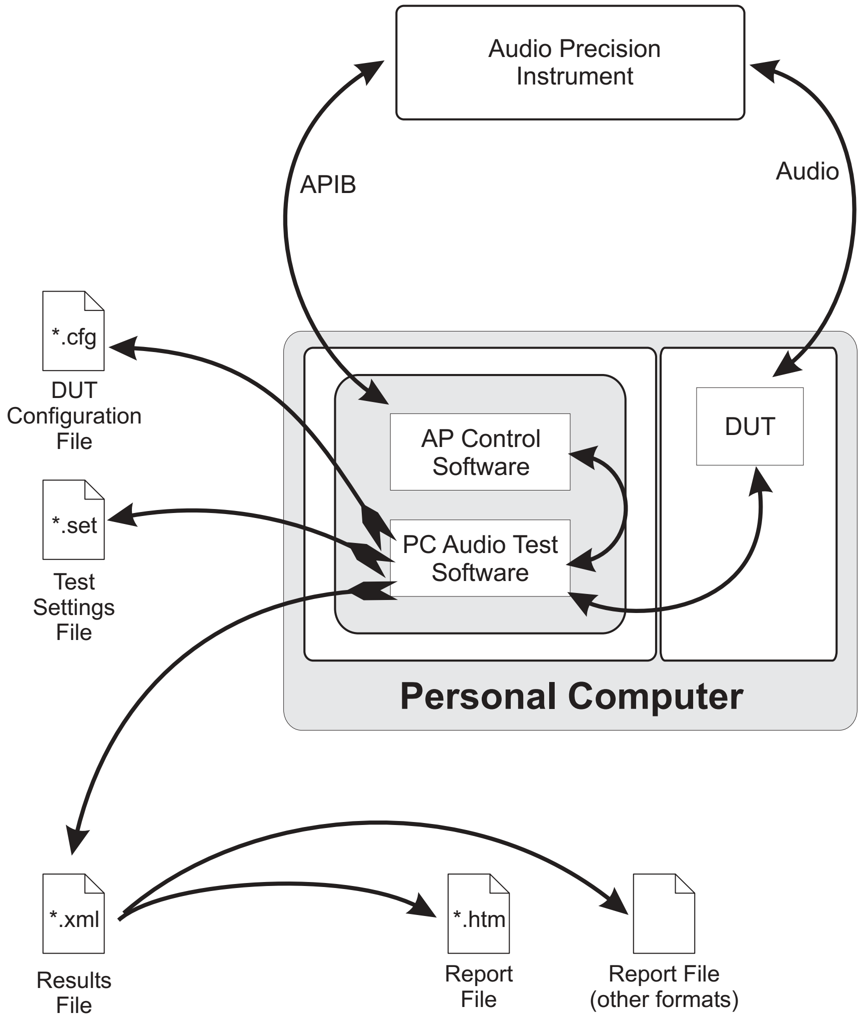


Figure 1. PC Audio Test system diagram (local configuration).

installed on a remote "target" computer. See Chapter 5 for information on using PC Audio Test in remote configuration.

Results are saved as XML text, which enables you to design custom reports that select and format the results for any purpose.

NOTE: PC Audio Test does not evaluate the MIDI or audio synthesis capabilities of any sound device.

Measurement Instrument Requirements

To run the tests, PC Audio Test requires

- an Audio Precision measurement instrument, such as System Two, System Two Cascade or a 2700 series instrument; for full PC Audio Test functionality, the instrument must have analog and digital input and output capabilities.
- the Audio Precision control software. The software release version must include support for PC Audio test.

In this manual we assume that you have an Audio Precision instrument and software compatible with PC Audio Test, and that you are familiar with the operation of the instrument. Complete information on the operation of these instruments is included with purchase, and is also available at the Audio Precision Web site.

Audio Precision Instrument	PC Audio Test Support	Control Software
SYS-2022, SYS-2300, SYS-2500, SYS-2122, SYS-2700, SYS-2702, SYS-2720	Instrument configuration does not include either analog or DSP capabilities and DOES NOT support PC Audio Test requirements	
SYS-2222	All PC Audio Test measurements except DIGITAL LOOP supported.	APWIN 2.24 or later.
SYS-2322	All PC Audio Test measurements supported.	APWIN 2.24 or later.
SYS-2422, SYS-2622	All PC Audio Test measurements except DIGITAL LOOP supported.	APWIN 2.24 or later; AP2700 3.00 or later.
SYS-2712	All PC Audio Test measurements except DIGITAL LOOP supported.	AP2700 3.00 or later.
SYS-2722-96k	All PC Audio Test measurements supported.	APWIN 2.24 or later; AP2700 3.00 or later.
SYS-2722-192k	All PC Audio Test measurements supported.	AP2700 3.00 or later.
ATS-2	not yet supported	

Check the Audio Precision Web site at audioprecision.com for up-to-date information on the specific Audio Precision instrument models and software versions that support APP-2010 PC Audio Test.

Recommended Instrument Analyzer Filters

Software filters (and, for SYS- family instruments, hardware filters) can be applied to the analyzer in Audio Precision instruments. The filter choices can include high-pass, low-pass and weighting filter options.

Since digital-to-analog converters (DACs) often have high-level out-of-band noise, their performance can be more accurately measured when the analyzer bandwidth is restricted to the audio band by a filter. Additionally, standards or test requirements may specify a bandpass or weighting filter for certain measurements.

Option Filters

Audio Precision manufactures a range of plug-in filter modules called Option Filters, which can be fitted in System Two (including System Two Cascade, Cascade *Plus* and 2700 series) instruments. Band-limiting low-pass filters with a knee at about 20 kHz and A-weighting, CCIR and CCIR/Dolby ARM filters are particularly useful in testing PC audio devices.

S-AES17 Filter

Audio Precision manufactures the S-AES17 Filter, which can be fitted in System Two, System Two Cascade, Cascade *Plus* and 2700 series instruments. Unlike the Option filters, the Audio Precision S-AES17 Filter inserts a low-pass filter section *previous to* the analyzer input, reducing high-level out-of-band signals before they can overload ranging or amplifier circuits. Use of an S-AES17 Filter is strongly recommended for PC audio device testing; the PC Audio Test default configuration settings expect an installed S-AES17 filter.

Basic Configurations

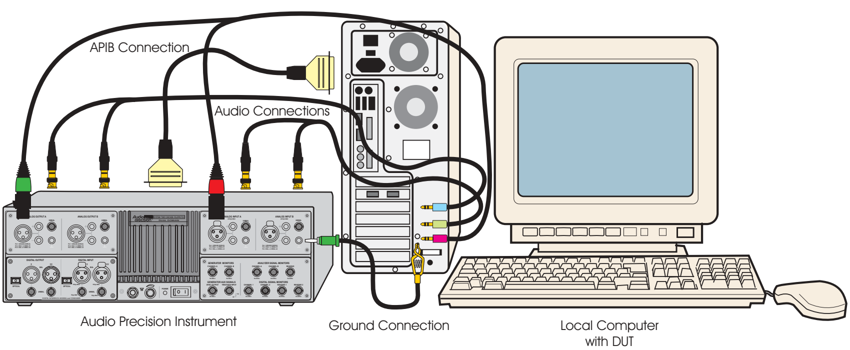


Figure 2. Local test configuration.

Figure 2 shows a typical PC Audio Test “local test” configuration. An Audio Precision instrument is connected to a PC that has both the instrument control software and PC Audio Test installed. Audio connections are made between the instrument and the sound device under test (or *DUT*) mounted in the PC.

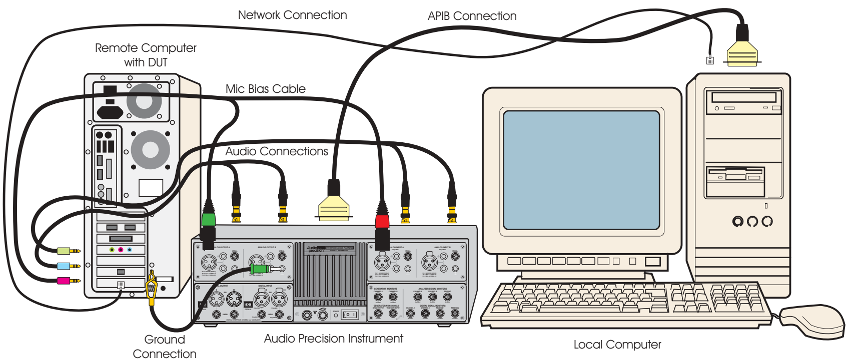


Figure 3. Remote test configuration.

Figure 3 shows a typical “remote test” configuration. In this case the instrument control software and PC Audio Test are installed in the host computer, which controls the instrument and runs the tests. The DUT hardware and a second instance of PC Audio Test are installed in the client computer. A network connection is shown between the two computers to enable remote operation using Microsoft Window’s DCOM facility.

Quick Tour

The next few pages will give you a quick tour of the PC Audio Test features and interface. Detailed information is provided in later chapters and referenced from the Quick Tour topics. See Chapter 2 for software and hardware installation instructions.

Refer to the **Quick Start Guide** (included with the PC Audio Test materials and as a PDF file on the CD-ROM) as you familiarize yourself with PC Audio Test.

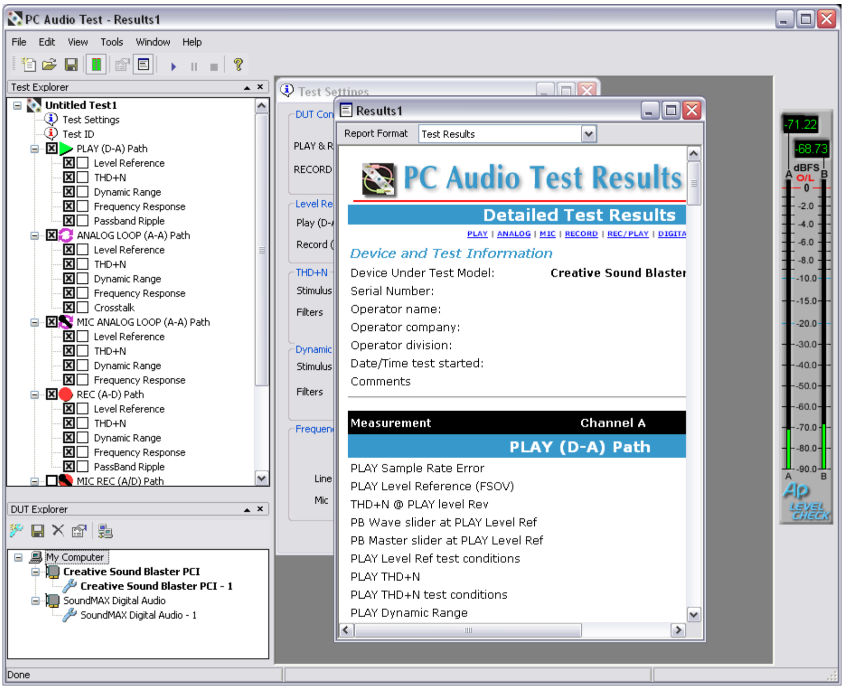


Figure 4. PC Audio Test workspace.

PC Audio Test launches with the Test Explorer and the DUT Explorer windows open, and with the Results viewer in the workspace. The real-time digital audio meter is displayed on the right.

Device Under Test (DUT)

PC Audio Test will query the PC (and the remote target PC, if connected and properly configured) to determine the sound device(s) installed. These installed sound devices are listed in the DUT (Device Under Test) Explorer window with a “sound card” icon. Each sound device listed has one or more configurations attached to it, designated by a wrench icon.

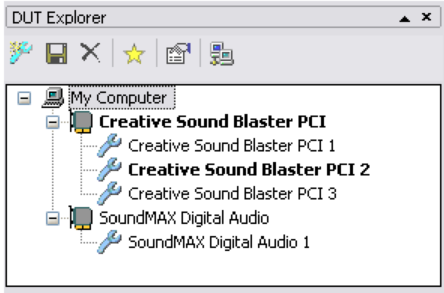


Figure 5. The DUT Explorer panel.

Choose the sound device and configuration you would like to test by setting the configuration to Active. Set a configuration to Active by selecting the configuration, then clicking the “star” icon in the DUT Explorer toolbar. When a configuration and sound device are set to Active, they are displayed in **BOLD** type.

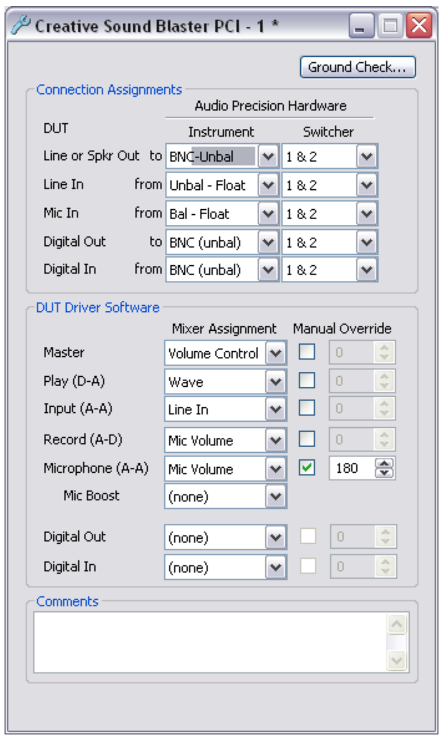


Figure 6. DUT Configuration panel.

A DUT must be configured for testing. Configuration establishes the software mixer assignments for the DUT functions and selects the measurement instrument ports and interface settings.

The default configuration for each DUT combines mixer assignments polled from the sound device driver and typical test settings. You can edit the default DUT configuration to match special characteristics of your DUT and the needs of your test. Once edited, DUT configurations can be named and saved as *.cfg files. For more information see **DUT Configuration** on page 18.

Paths and Measurements

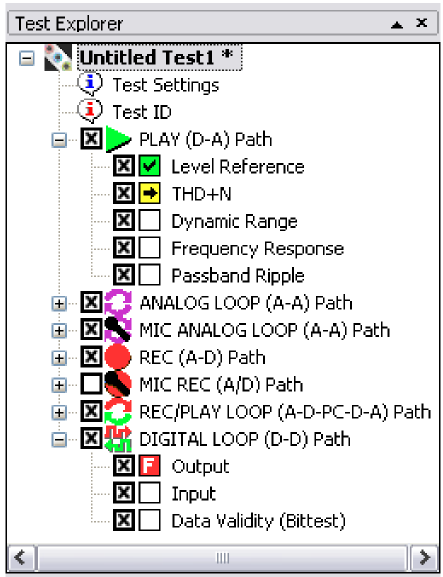


Figure 7. The Test Explorer panel.

PC sound devices operate over various signal paths, such as PLAY, RECORD or ANALOG LOOP. Within each of these paths, a number of measurements can be made to assess the performance of the device operating in that path.

PC Audio Test enables you to select which measurements and measurement paths you want to test in a given session. The paths and measurements are displayed in the Test Explorer window as a hierarchical tree. Individual measurements or entire paths and can be enabled or disabled by clicking in the adjacent check boxes. See Chapter 3 for more information about choosing paths and measurements.

Test Settings

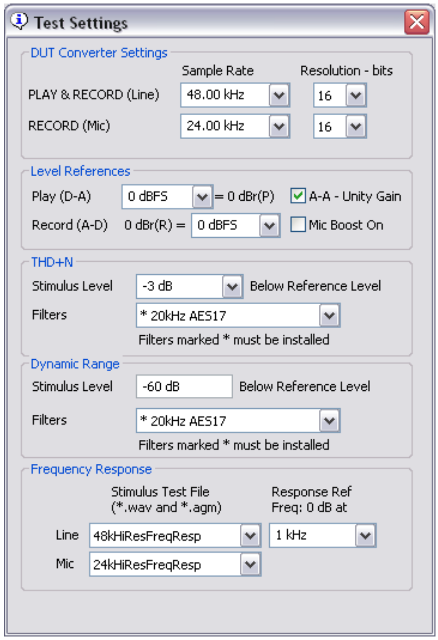
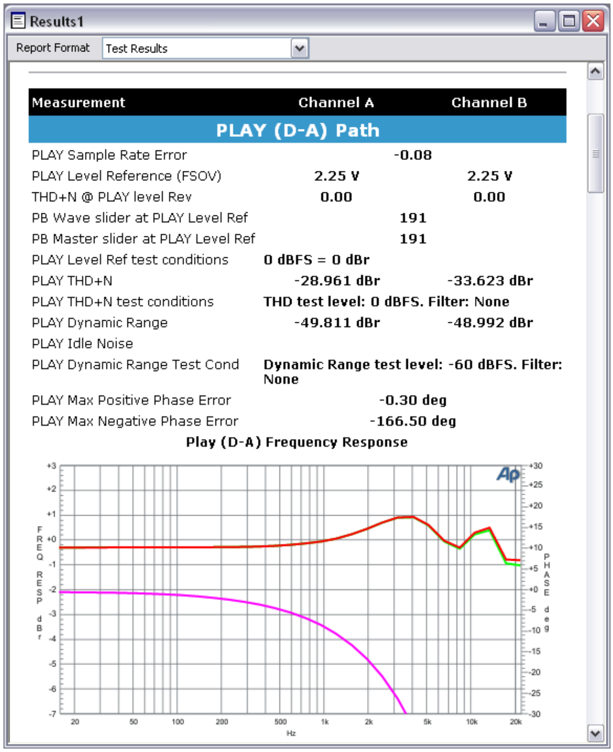


Figure 8. Typical Test settings panel.

Each of the tests has certain properties that can be set, such as sample rate, stimulus level, low-pass filtering and so on. This collection of properties can be named and saved as a *.set file. See **Test Settings** on page 22.

Test Results



Measurement	Channel A	Channel B
PLAY (D-A) Path		
PLAY Sample Rate Error	-0.08	
PLAY Level Reference (FSOV)	2.25 V	2.25 V
THD+N @ PLAY level Rev	0.00	0.00
PB Wave slider at PLAY Level Ref	191	
PB Master slider at PLAY Level Ref	191	
PLAY Level Ref test conditions	0 dBFS = 0 dBr	
PLAY THD+N	-28.961 dBr	-33.623 dBr
PLAY THD+N test conditions	THD test level: 0 dBFS. Filter: None	
PLAY Dynamic Range	-49.811 dBr	-48.992 dBr
PLAY Idle Noise		
PLAY Dynamic Range Test Cond	Dynamic Range test level: -60 dBFS. Filter: None	
PLAY Max Positive Phase Error	-0.30 deg	
PLAY Max Negative Phase Error	-166.50 deg	

Figure 9. The Results Viewer.

The Results Viewer provides an HTML formatted view of the current XML test results, updated in real time. Current results can be named and saved as an *.xml file.

Reports

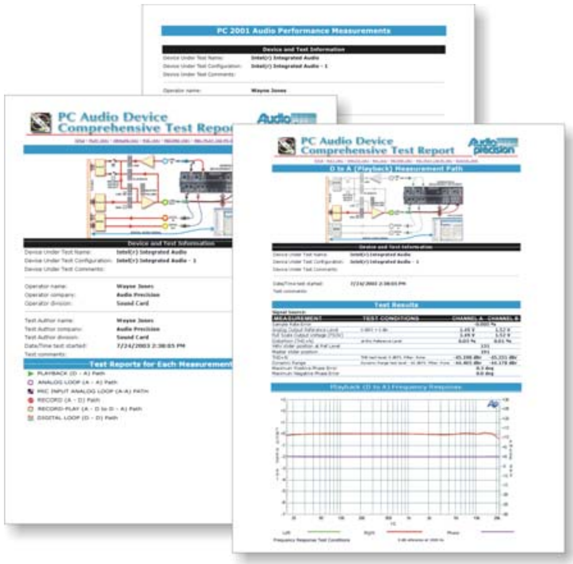


Figure 10. Typical HTML Reports.

PC Audio Test results are stored as XML text, which can easily be converted into many different report formats. HTML templates are included to get you started generating reports. You can write your own HTML templates or import the XML results data into compatible spreadsheet, database or word processor applications.

Remote PC Device Testing

PC Audio Test can be installed on a host computer and can acquire a full set of measurements from a DUT installed on a remote client or target computer.

The host computer must be connected to the Audio Precision instrument performing the measurements and have both PC Audio Test and the instrument control software installed.

The target computer must have PC Audio Test installed, be connected to the host computer via a network connection, and must be properly configured for DCOM remote operation. DCOM is a distributed computing feature included with Microsoft Windows 2000 and Windows XP. We do not recommend using Windows 98 for remote testing..

See Chapter 5 for more information about making remote measurements from a target computer using DCOM.

Cables

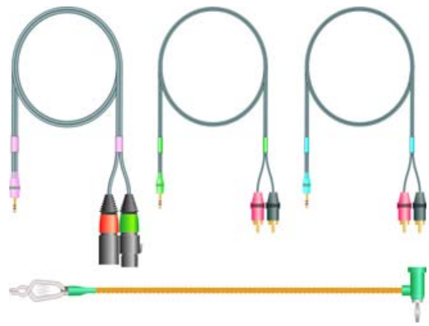


Figure 11. PC Audio Test Cable Set.

Several cables are included with PC Audio Test to help you get started quickly and to be sure that you have a proper interface: two unbalanced shielded standard audio cables, fitted with BNC connectors and 3.5 mm TRS plugs; one “Mic Bias” cable, fitted with one male and one female XLR connector and a 3.5 mm TRS plug; and a grounding cable.

The three audio cables are color-coded to correspond to the standard recommended identifying colors used for PC card and motherboard audio jacks:

- lime green should be connected to the PC audio device line inputs
- light blue should be connected to the PC audio device line outputs (or speaker connections, depending on the device and your test goals)
- pink should be connected to the PC audio device mic input (for most PC audio devices)

Chapter 2

Getting Ready

This chapter discusses software installation and the interconnections and configuration necessary to set up a PC audio test. We recommend that you read this chapter carefully, and that your first test be designed for a local sound device, one mounted in the same PC that is controlling your Audio Precision instrument. Local testing is described in Chapter 3. If you are testing a PC audio device mounted in a remote client PC, refer to the DCOM information in Chapter 5 after you have mastered local configuration and testing.

Installing the Software

- Close all applications
- Insert the APP-2010 PC Audio Test disk into the CD-ROM drive.
- The Windows Autorun features should automatically open the installation menu shown in Figure 12. If Autorun is not enabled on your

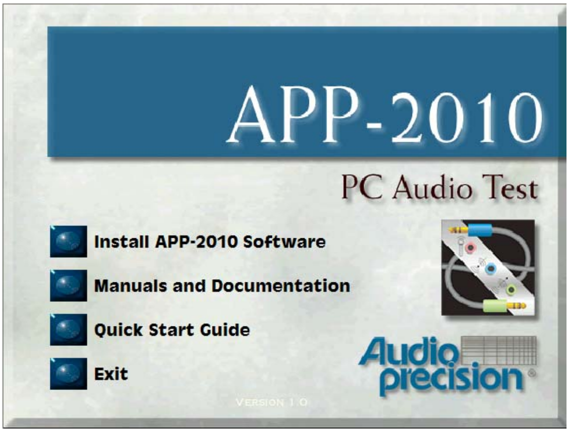


Figure 12. APP-2010 PC Audio Test Installation Screen.

computer, click the **Start** button on the Windows taskbar. Then click **Run** and type **D:\Setup** and then **OK**, where "D" is the drive letter of the CD-ROM drive.

The installation menu offers 4 choices:

- **Install APP-2010 Software**
  Click **Install APP-2010 Software** to begin installation.

  NOTE: APP-2010 PC Audio Test requires the correct version of Audio Precision control software to be installed on the computer that is controlling your Audio Precision instrument (see the table on page 3). If you do not already have the correct control software installed on your computer, be sure to install it now, before running PC Audio Test.

- **Manual and Documentation**
  Click **Manual and Documentation** to open a pdf menu listing user documentation for PC Audio Test, with links to user documentation pdfs on the CD-ROM.

- **Quick Start Guide**
  Click **Quick Start Guide** to open the PDF version of the Quick Start Guide included with PC Audio Test.

- **Exit**
  Click **Exit** to leave the installation program.

Launching APP-2010 PC Audio Test

NOTE: You must have a required version of Audio Precision control software installed on the PC to successfully launch PC Audio Test. If PC Audio Test cannot detect a correct version of Audio Precision control software on your PC, the program will display a warning dialog and will not open.

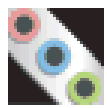
Run the Control Software First

NOTE: When your installation is complete, you must run your Audio Precision control software BEFORE you run PC Audio Test for the first time.

PC Audio Test requires Audio Precision control software to operate, and the control software must make certain entries in the registry area of Microsoft Windows before PC Audio test can be successfully opened. Be sure that the instrument control software has been run at least once before opening PC Audio Test for the first time. After this initialization, PC Audio Test can be run at any time.

If Audio Precision control software has not previously been installed on your computer, refer to the documentation included with your Audio Precision instrument, particularly the *Getting Started* manual for the instrument. The *Getting Started* manual will guide you through the necessary steps for proper hardware connection and software installation.

Opening APP-2010 PC Audio Test



Open PC Audio Test from the Start menu by choosing **Start > All Programs > Audio Precision > PC Audio Test > PC Audio Test**, or by clicking the shortcut button shown at right.

Before you can test a PC audio device, you must connect the hardware and configure the device, as discussed next.

DUT Selection and Configuration

A personal computer or a networked computer system can have many PC sound devices available. These can be used independently, or in conjunction with each other for multiple-channel work. Because PC sound devices vary greatly, representing many different design goals, feature sets, hardware implementations and software drivers, PC Audio Test attaches one or more custom configuration files to each audio device to define DUT and instrument connections and driver software settings.

The DUT Explorer

The DUT Explorer enables you to select a PC sound device as the current device under test (DUT), and configure the DUT and your Audio Precision instrument for testing.

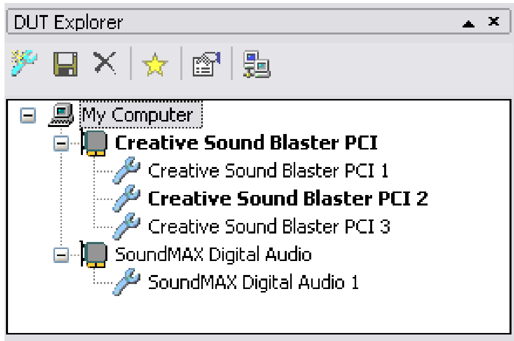


Figure 13. The DUT Explorer, showing multiple configurations for the DUT. The configuration numbered "2" is active.

The DUT Explorer window shows all PC sound devices available to your PC, whether local or across a network connection. Choose the sound device to test (your DUT for this session) from this window.

Testing a remote sound device (across a network connection) is discussed in detail in Chapter 5.

Viewing the Device Properties

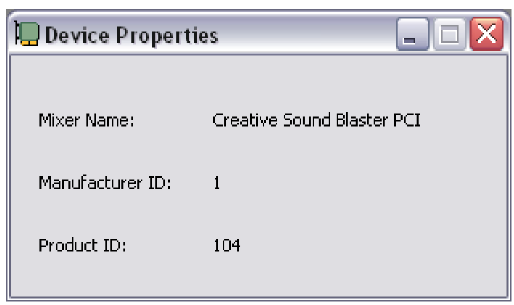


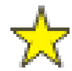
Figure 14. Viewing the Device Properties.

PC Audio Test can read certain device properties for the DUTs installed on your system. Double-click a DUT branch to view the Device Properties window for that DUT.

Selecting a DUT Configuration

Each DUT listed in the DUT Explorer has one or more configurations associated with it. A DUT configuration (identified by a wrench icon) defines the settings used to enable correct driver control and audio signal routing for the DUT.

A default configuration is assigned to each DUT. Configurations can be edited, named and saved as *.cfg files. Saved files can be opened and assigned to the selected DUT.



You may have many configurations for each DUT, but only one configuration can be active at any time. To select a DUT and set a configuration to active, choose a configuration branch and click the star button on the DUT toolbar; or, right-click in the DUT Explorer and choose Set Active from the menu.

NOTE: If you have a sound device on the local computer and a second sound device on the remote computer that each report the same manufacturer and model name to the operating system, the matching sound devices will share the same PC Audio Test configuration files.

Viewing or Editing a DUT Configuration

To view or edit a DUT configuration, select a configuration branch and click the View the selected configuration button on the DUT toolbar; or, double-click the configuration branch; or, right-click in the DUT Explorer and choose Properties from the menu. The selected DUT Configuration panel will open.

The DUT Configuration panel

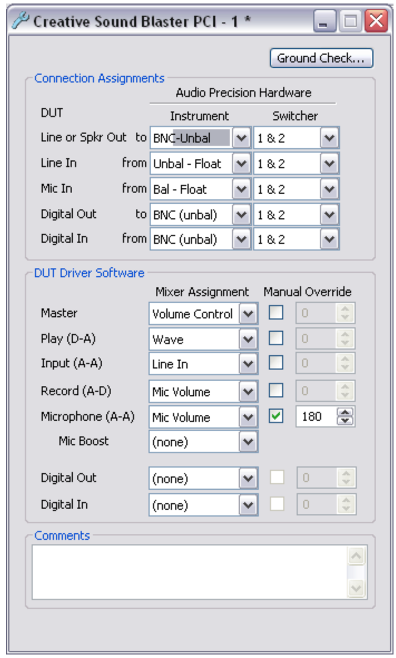


Figure 15. The DUT Configuration panel.

Assigning Connections

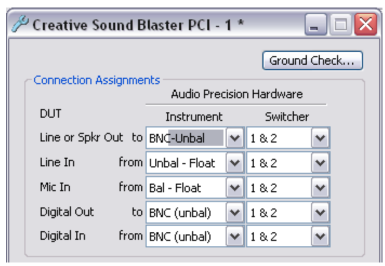


Figure 16. DUT instrument connection and switcher assignments.

The top area of the DUT Configuration panel enables you to assign the Audio Precision instrument ports and switcher channels to the DUT input an output ports.

The DUT Line Out / Speaker Out ports, for example, can be assigned to the instrument **BNC-Unbal** or **XLR-Bal** analyzer inputs. In a similar fashion, you can assign the other DUT ports to the available instrument ports.

NOTE: You must be sure that your cable interconnections match the software selections you have made on this panel. The Connection Assignments feature only informs the instrument or switcher of your port choices.

If you are using an Audio Precision switcher (such as an SWR-2122 series switcher) as a component of a PC sound device test, you can select which pairs of switcher channels are assigned to your DUT input or output ports.

Ground Check

In any system of audio devices, good interconnection practice is essential to maintain signal integrity. Connections with inadequate shielding, high-impedance ground paths or the multiple ground paths called "ground loops" can introduce hum, buzz and even radio-frequency interference into the audio signal, greatly reducing the accuracy of any measurements.

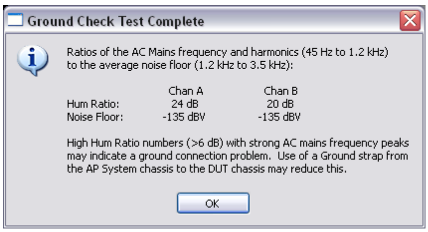


Figure 17. Ground Check report.

The **Ground Check** button tests your connections for ground-related problems such as these. The test measures the ratio of mains frequency and mains harmonics peaks in the 45 Hz to 1.2 kHz range to the average noise floor in the 1.2 kHz to 3.5 kHz range. Ratios greater than 10 dB may indicate ground connection problems.

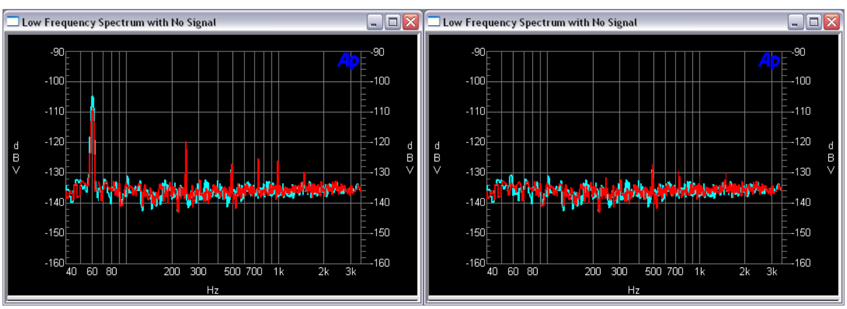


Figure 18. Ground Check graphs. Left shows 24 dB and 20 dB ground ratios; right shows negligible ground interference.

If your system exceeds a 10 dB ratio in either channel, any subsequent measurements you make in this configuration are suspect. Check the integrity of your cables, their routing (proximity to devices that may couple magnetically or electrostatically, etc) and be sure you have a low-impedance (large-gauge) ground connection (such as the ground cable supplied with PC Audio Test) between your Audio Precision instrument and the DUT (see page 30).

Assigning Mixer Sliders

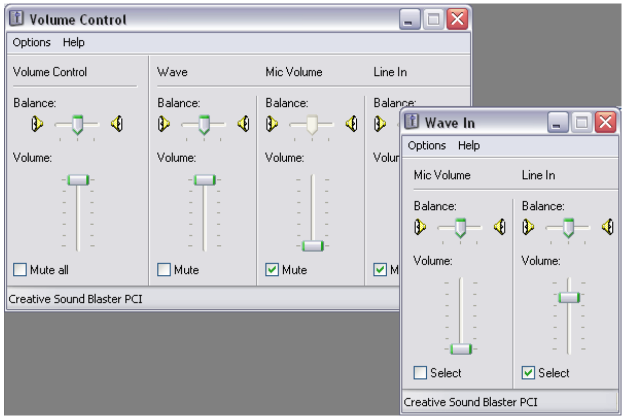


Figure 19. Typical Playback (left) and Recording Mixer windows.

Each PC audio device has hardware components and software driver elements that work together to route and control the audio signal through the device. These controls are usually displayed in one of two windows or window panels, often called “mixers.” The Playback mixer window shows controls that select and adjust signals routed to the Line Out jacks, and the Recording mixer window shows controls that select and adjust the signal to be routed to the recording ADC. The mixers offer “slider” volume and balance controls, Mute and Select switches, and often include tone controls, controls for effects such as surround, reverberation or “wide stereo” settings.

NOTE: For testing purposes, all other PLAY mixer sliders must be muted; balance and EQ or tone controls, if any, must be set to their neutral positions, and all effects such as Surround, Reverb or Wide Stereo must be disabled.

PC Audio Test must be able to control routing and level for each audio device under test. The program queries the driver software for the DUT and provides lists of all the volume controls available for the relevant DUT inputs and outputs.

You must select the mixer assignment control from the list for each of the DUT inputs and outputs. In many cases there is only one reasonable selection (such as Microphone for the Mic input), but because the different architecture

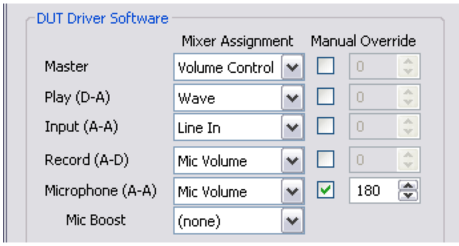


Figure 20. DUT Mixer slider assignments.

and naming conventions used by manufacturers it may not be possible to automatically choose the appropriate volume control for your intention.

Automatic and manual level setting

In the course of making its various measurements PC Audio Test will automatically adjust the volume level of various mixer sliders.

In most cases the automatic level setting will give you the best results. However, you may want to manually set a particular driver control, either because your test specifies a particular value, or because the PC audio device you are testing does not conform to typical control assignments and cannot be controlled automatically.

The fields to the right of each slider assignment selector enable you to override the PC Audio Test settings and enter a fixed volume setting. Your testing, for example, may require that the PLAY (A-D) volume be always set to a particular value, rather than be automatically optimized by PC Audio Test. See Manual Level Setting on page 81.

To set the level manually, click the checkbox for that mixer slider. The setting field will become available. You can enter the level setting directly in the field or select the level setting using the scroll arrows.

When a slider control is set to manual, all measurements in that measurement path will be referenced to the signal controlled by your manual setting. Measurements in other paths will be unaffected and will continue to operate with automatic level setting.

Mic Boost Assignment

The Mic Boost assignment on the DUT Configuration panel does not turn the Mic Boost function ON or OFF. That is done by clicking the Mic Boost checkbox on the Test Settings panel. Mic Boost assignment merely selects the driver control for the Mic Boost function. If you intend to use Mic Boost in your test, be sure that the Mic Boost assignment is set to a valid control (usually **Microphone Boost**).

Test Settings

By default, PC Audio Test characterizes a sound device under test (DUT) with a full suite of measurements, performing level checks, noise, distortion and frequency response measurements on the DUT through all the signal path modes available.

In many cases, however, you may want to specify certain measurement parameters or run only a subset of the whole suite of measurements. The Test Explorer and the Test Settings panel enable you to customize your choice of modes, measurements and setups.

Both Test Explorer settings and Test settings can be saved and reloaded as a PC Audio Test file, which uses the filename extension *.set.

The Test Settings dialog box

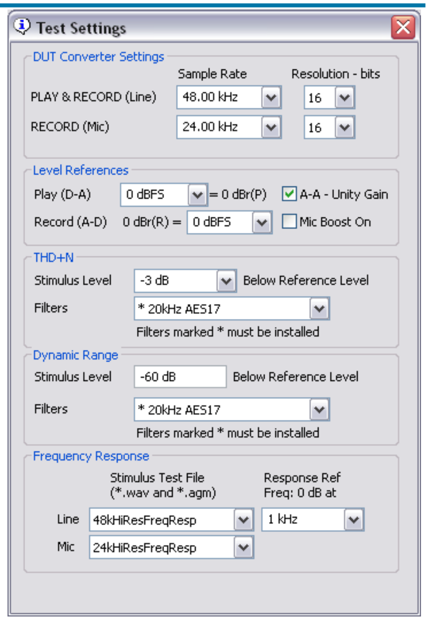


Figure 21. The Test Settings dialog box.

The Test Settings panel enables you to view and set specific measurement parameters and other test settings.

Double-click on **Test Settings** to open the Test Settings dialog box.

The Test Settings dialog box enables you to make settings for each test. The top section provides fields for setting sample rate and resolution for both Line In and Mic In recording.

Each drop-down list shows only the sample rates and resolutions available to the current DUT, with the most common setting selected as a default.

Digital Settings

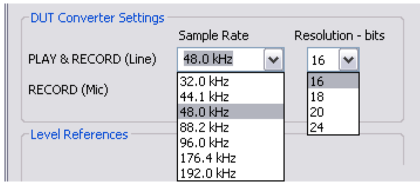


Figure 22. Test Settings digital settings.

Set the sample rate (Fs) and resolution (also called word length or bit depth) for your test here.

In PC Audio Test the sample rate for the DUT’s analog-to-digital converter (ADC) and digital-to-analog converter (DAC) must be set to the same value; likewise, the resolution for both the ADC and the DAC must be the same. The selections made here set the sample rate and resolution for both the PLAY mode and the RECORD mode.

Some tests require that you set the sample rate or resolution when using Mic In to a different value from the Line In settings. PC Audio Test enables you to specify sample rates and resolutions for both modes. When performing a series of measurements that specify both Mic and Line inputs, PC Audio Test will use the selections you have made here.

Level Reference Settings

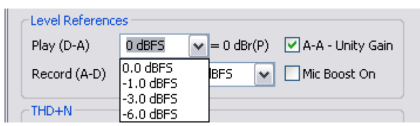


Figure 23. Test Settings level reference settings.

See the **Level Reference** sidebar on page 38.

There are two key level references settings in PC Audio Test.

- **PLAY (D-to-A) level reference**
  PLAY (D-to-A) level reference establishes the relationship between a particular digital level (the default is 0 dBFS) at playback and the corresponding electrical level at the analog Line Out jacks, which are normalized as 0 $dBr_{(PLAY)}$ (A and B). This level is also referred to as FSOV or Full Scale Output Voltage.

0 $dBr_{(PLAY)}$ (FSOV)

0 dBr(REC)
(FSIV)

- **RECORD (A-to-D) level reference**
  RECORD (A-to-D) level reference establishes the electrical level at the analog input (normalized as 0 $dBr_{(REC)}$) required to cause a particular digital level (the default being 0 dBFS) to be recorded. This level is also referred to as FSIV or Full Scale Input Voltage.

Some standards specify and some measurements require other digital level references, typically –1 dBFS, –3 dBFS or –6 dBFS. You can select any of these values or enter a value of your choice in the Level Reference setting field for either the PLAY or RECORD Level Reference.

Other settings in the Level Reference area of the panel are:

- **A/A - Unity Gain**
  The **A/A - Unity Gain** checkbox sets the Line In slider so that

  Input Voltage = *Output Voltage* (Unity Gain).

- **Mic Boost**
  The **Mic Boost** checkbox allows you to set the DUT's Mic Boost function **ON** or **OFF** for PC Audio Test use.

Mic Boost adds a fixed amount of gain to the PC audio device Mic In circuit for the additional amplification often needed when using a microphone as a source. Mic Boost gain is typically 20 dB. Not all DUTs or DUT software drivers feature a Mic Boost function.

THD+N Settings

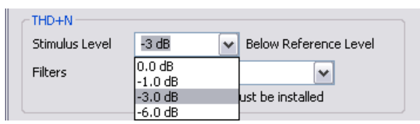


Figure 24. Test Settings THD+N settings.

See the **Distortion (THD+N)** sidebar on page 44.

The THD+N distortion measurement applies a 997 Hz signal to the DUT as a stimulus and measures the distortion products created in the DUT. By default, the stimulus level for THD+N measurements is the level that corresponds to –3 dBFS (for PLAY measurements) or –3 dBr (for RECORD and ANALOG LOOP measurements).

Some standards or measurements may require other THD+N stimulus levels, typically 0 dBFS, –1 dBFS or –6 dBFS. You can select any of these values or enter a value of your choice in the THD+N Stimulus Level setting field.

When measuring THD+N, it is not uncommon to use signal filtering (such as a low-pass filter or a weighting filter) in the analysis. In PC Audio Test THD+N measurements, the default is the 20 kHz AES17 filter. The second field in the THD+N settings area allows you to select a different filter (or no filter) in your Audio Precision instrument for THD+N measurements.

NOTE: Most of the filters are optional hardware filters, marked with an asterisk in the drop-down list. Any filter you choose that is marked with an asterisk must be physically installed in the Audio Precision instrument for filter functionality. If you select a filter that is not installed in the instrument, an error message from the control software states "An internal error occurred. Value is over list item max."

Dynamic Range Settings

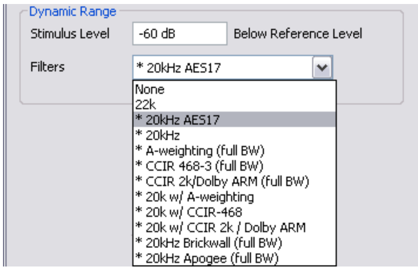


Figure 25. Test Settings dynamic range settings.

See the **Dynamic Range** sidebar on page 48.

The dynamic range measurement applies a very low level 997 Hz signal to the DUT to prevent the converter from muting during noise measurements. By default, the level of this signal is set at –60 dBFS/dBr.

Some measurements may require other levels for the mute defeat tone. You can enter a value of your choice in the Dynamic Range Stimulus Level setting field.

Like the THD+N measurements, it is not uncommon to use signal filtering (such as a low-pass filter or a weighting filter) in dynamic range measurements. In PC Audio Test dynamic range measurements, the default is the 20 kHz AES17 filter. The second field in the Dynamic Range settings area allows you to select a different filter (or no filter) in your Audio Precision instrument for dynamic range measurements.

NOTE: See the note above regarding hardware option filters for THD+N measurements. The same applies here.

Frequency Response settings

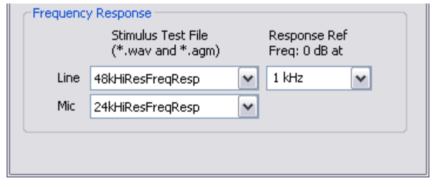


Figure 26. Test Settings frequency response settings.

See the **Frequency Response** sidebar on page 53.

Unlike the Level Reference, THD+N and dynamic range measurements, which use single-tone stimulus signals, the frequency response measurements use multitone techniques, with stimulus waveforms stored as digital audio files.

By default, the multitone files selected for frequency response contain the ISO31 set of frequencies at the current sample rate. You can select other multitone files from the drop-down lists provided. Separate selections are available for Line In and Mic In modes due to the possibility of different sample rates and resolutions for the modes, requiring different multitone files.

Frequency response result levels are normally referenced to the result level at a mid-range frequency, usually 1 kHz. For PC Audio Test frequency response measurements, the default reference frequency is 1 kHz. You can enter a another value of your choice in the Frequency Response Reference Frequency setting field.

Test ID

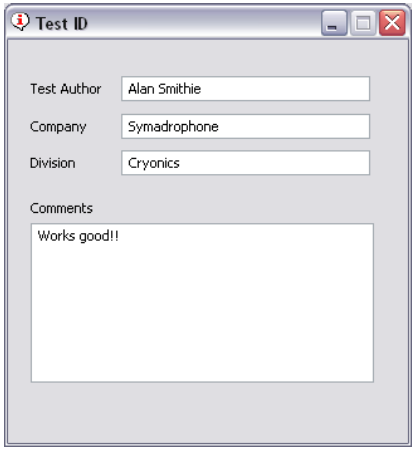


Figure 27. The Test ID dialog box.

Double-click on Test ID in the Test Explorer to open the Test ID dialog box.

The Test ID dialog box enables you to identify each test with an operator's name, company name, division and a comment. The Test ID is specific to each test file, as opposed to the User Information, which persists throughout different tests.

If you have entered User Information, this information will appear as the default Test ID information for a New Test.

See User Information on page 27.

User Information

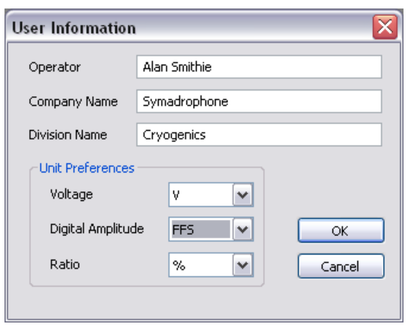


Figure 28. The User Information dialog box.

The User Information dialog box enables you to enter a Company Name, Division name and User Name that persists across tests. This information is entered as the default information in the Test ID for a New Test.

To check or enter User Information, choose **Tools > User Information** from the Main menu.

See Test ID on page 27 .

Connecting the Hardware

A complete set of tests requires analog audio connections between the Audio Precision instrument generator and the DUT inputs, and from the DUT outputs to the instrument analyzer. Some DUTs may also require digital audio input and output connections between the DUT and the instrument.

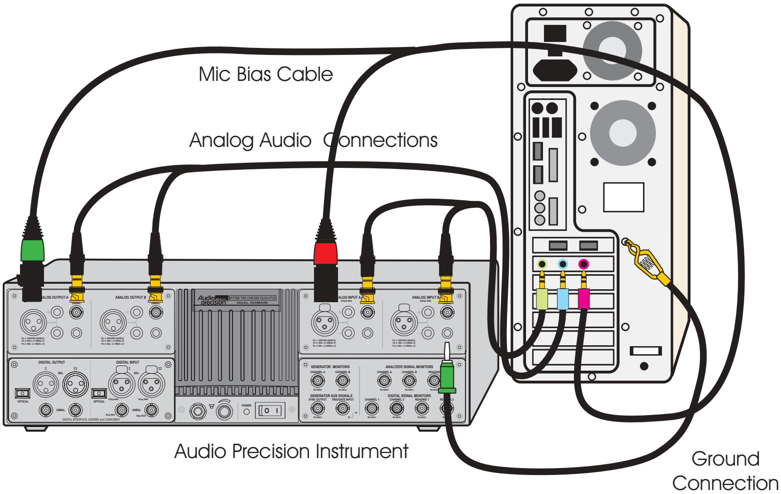


Figure 29. Typical audio and ground connections between a DUT and an Audio Precision instrument for PC Audio Test.

When making these connections, care must be taken that level, impedance, balanced/unbalanced configuration and XLR pin connections are correctly set.

An additional electrical common connection (usually called a *ground* or *earth* connection) will often improve the quality of the measurements by minimizing ground-related noise problems. Connect the ground cable between an instrument ground lug and a grounded screw or other grounded point on the target computer chassis, near the DUT jacks.

Typical PC audio device Inputs and Outputs

Most PC audio devices have at least a monaural Mic Input and a stereo Line/Speaker Output. Most also have a stereo Line Input; some separate the Line and Speaker Outputs; and some add a Digital Input and Output.

These connections are almost always in the form of 3.5 mm jacks, and are often labeled with graphical symbols and colored jack designations, as shown in Figure 30.

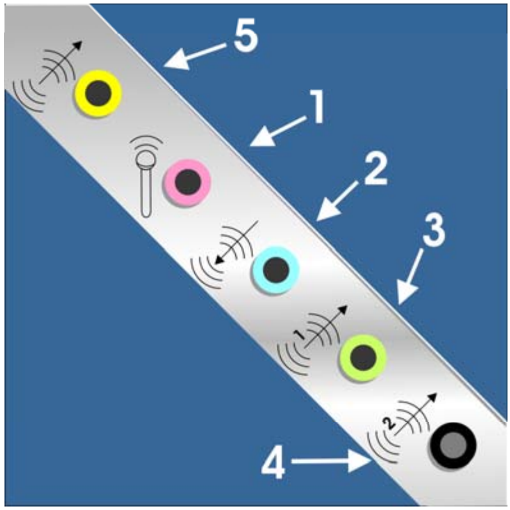


Figure 30. Typical PC sound device connections. Not all sound devices will have all these connections, and not all will use these colors or these symbols.

Typically, the pink or red jack (1) is the Mic input, usually monaural. The blue jack (2) is the Line input, the green jack (3) is the primary Line/ Speaker output, and the black jack (4) is the secondary Line/Speaker output. The yellow jack (5) is often the Digital output, although some manufacturers designate it a multi-purpose (Versatile) jack with selectable features.

PC Audio Cable Set

The cable set (Figure 31) provided with PC Audio Test includes the ground cable and the unbalanced input and output audio cables illustrated in Figure 29, and also a special cable for testing a mono microphone input while measuring the Mic In bias voltage, as explained on page 49.

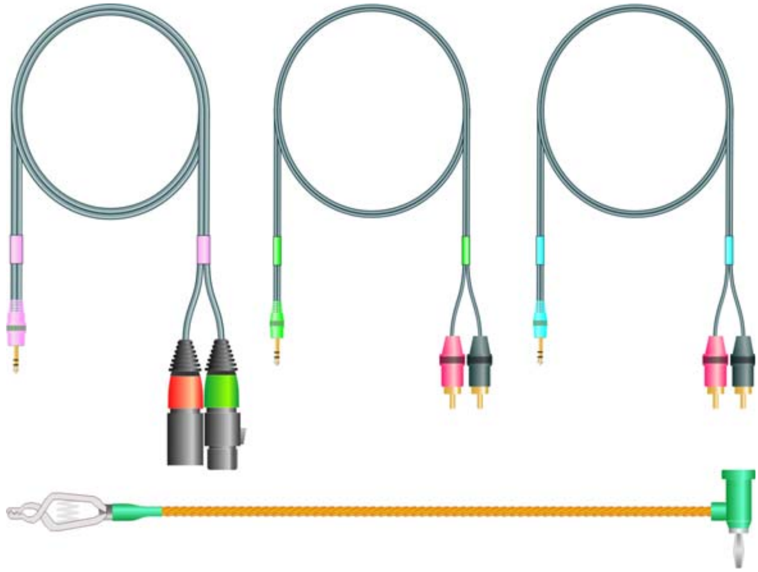


Figure 31. PC Audio Test Cable Set. On the left is the special Mic Bias cable; next are the unbalanced input and output audio cables; and below is the ground cable.

Audio Cables

The unbalanced audio input and output cables are terminated at the DUT end with a stereo TRS 3.5 mm plug and at the instrument end with BNC connectors (or in some cases RCA connectors fitted with BNC adapters). For convenience, the cables are color coded at the DUT end to match the standard PC audio device jack colors, light blue for Line In and light green for Line Out or Speaker Out.

Mic Bias Cable

The special Mic Bias cable enables you to simultaneously test a mono Mic In function and measure the microphone bias voltage and current capability. This cable has a specially wired 3.5 mm TRS plug at the DUT end, colored pink to match the standard Mic In color. At the instrument end of the cable are two XLR connectors. The female XLR is connected to apply signal to the DUT on the tip of the 3.5 mm plug, and should be connected to the instrument Analog Output A. The male XLR is connected to read the DUT microphone bias voltage on the ring of the 3.5 mm plug, and should be connected to the instrument Analog Input A.

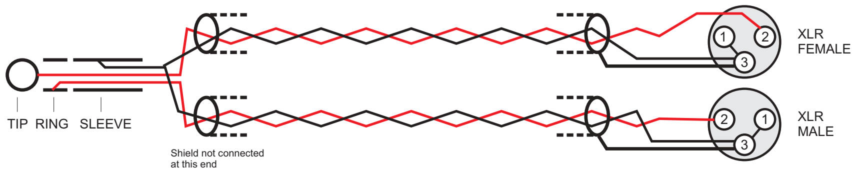


Figure 32. PC Audio Test Mic Bias cable wiring.

Ground Cable

The ground cable has a clip at the DUT end for attachment to the computer chassis, and a banana connector at the instrument end for insertion into a ground lug, marked with the symbol shown here in the margin.

Chapter 3

Running the Tests

Introduction

The group of measurements performed by PC Audio Test is called a *test*. A test can include measurements of all the key parameters of a DUT in all available measurement paths, or it can be restricted to measure only a few parameters in a restricted set of paths.

This chapter describes how to select measurement paths and specific measurements and perform tests on your DUT. Your configuration, settings, and results are saved as part of the test procedure.

- DUT configuration (see page 16) is saved in a *.cfg file.
- Test settings (see page 22) are saved in a *.set file.
- Test results (see page 66) are saved in a *.xml file.

Before a test can be successfully run, you must be sure that the DUT hardware and your Audio Precision instrument are properly connected, and that the instrument and DUT software controls are properly configured. Connections and configuration are described in Chapter 2.

XML tag notation in this chapter

Each test result has an XML *tag* or *collection name* associated with it. When re-formatting existing reports or creating new ones, you will need to know the tag associated with the results you report. In this chapter, boxes in the margins will identify both the result description (blue box) and the XML tag (white box) for that result.

Result Name

<ResultTag>

Tables in Appendix B list all results tags.

The Test Explorer

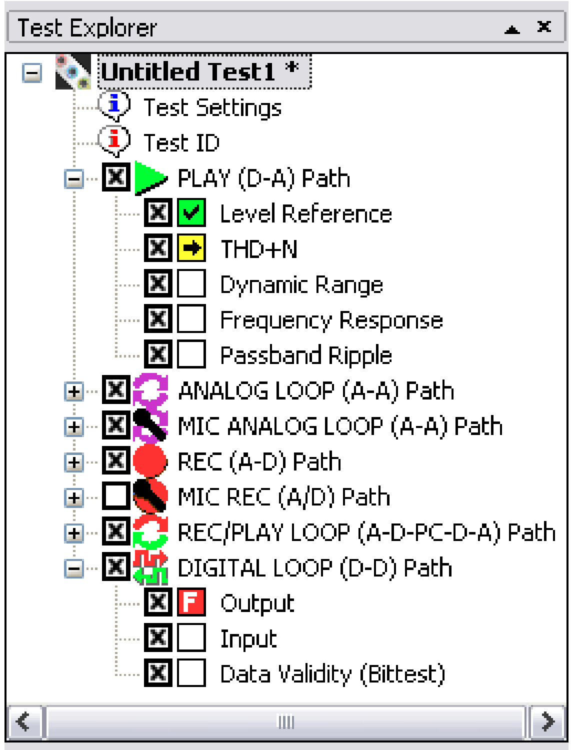


Figure 33. The Test Explorer.

The Test Explorer (Figure 33) displays the measurement paths and measurements in a hierarchical tree structure. You can select or deselect a particular measurement or entire measurement paths.

The highest level of the tree is the test, identified by the test name. Double-clicking on this branch will expand or collapse the tree display.

A new test settings file is named **Untitled Test 1**. From the File menu, you can save a new test settings file with an identifying name by choosing **File > Save As**, or open a previously saved test file by choosing **File > Open**. Only one test can be open at a time.

> *The document* Personal Computer Audio Quality Measurements *(PCAQM), which has been an important resource for Microsoft's WHQL audio standards and also for our work, identifies measurement paths using abbreviations like PC-D-A (Personal Computer-to-Digital-to-Analog). These PCAQM abbreviations are used in the Test Explorer and in documentation where appropriate.*

The first two selections under the test level are Test Settings and Test ID. Double-clicking either of these opens dialog boxes that enable you to set various technical and administrative preferences. These are discussed in detail in Chapter 2.

Below Test ID are the various test measurements, each under a measurement signal path branch such as PLAY or RECORD.

The Measurement Paths

After the Test Settings and Test ID branches are the seven *measurement paths*. A measurement path represents the configuration of hardware and software to test a particular set of functions in the DUT. Not all PC audio devices will have all of these paths available.

The measurement paths are:

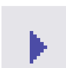
- PLAY
  (Digital-to-Analog Playback; PC-D-A)
  This measurement path tests the digital-to-analog converter (DAC) and the analog output circuit. The overall level reference for all measurement paths is set in the PLAY path, measuring the analog output level when a digital file of known level is played.
- ANALOG LOOP
  (Line In to Line Out; A-A)
  This measurement path tests only the analog input and output circuits, bypassing the analog-to-digital converter (ADC) and the DAC. The line input is used for this path.
- MIC ANALOG LOOP
  (Mic In to Line Out)
  This measurement path is identical to the ANALOG LOOP mode, except that it uses Mic In instead of Line In as the analog input.
- RECORD
  (Line In Analog-to-Digital Recording; A-D-PC)
  This measurement path tests the analog input and the ADC, using the line input.
- MIC RECORD
  (Mic In Analog-to-Digital Recording; A-D-PC)
  This measurement path tests the analog input and the ADC, using the mic input.
- RECORD/PLAY
  (Line In Analog-to-Digital Recording, then Digital-to-Analog Playback of the file just recorded; A-D-PC-D-A)

This measurement path is a combination of the RECORD and PLAY paths, using the line input.

- DIGITAL LOOP
(Digital In to Digital Out Pass-Through)
This measurement path tests the digital interface receiver and transmitter with special digital tests that provide information about the DUT's handling of data and metadata.

Running the Tests

- First, be sure you have configured your DUT for PC Audio Test as discussed beginning on page 16. Run Ground Check.
- Check the connections between your Audio Precision instrument and the DUT.
- Make your test settings (page 9).
- Select the measurement paths and measurements you would like to make in your by checking or unchecking the boxes next to the paths or measurements in the Test Explorer.



Now that you are ready, click the **Run** button to begin the test procedure. You can watch the progress of your test as status indicators appear next to the measurements in the Test Explorer. Measurement results will begin to populate the HTML template in the Results Viewer as the test progresses.

The yellow box with the arrow indicates a measurement-in-process.

The checked green box indicates a measurement successfully completed.

The red box with the white F marks a measurement that has failed, or has been stopped before completion.

In most cases, your test will proceed through the end and stop itself. At that point you could print the Test Results shown in the Test Viewer and call it a day.

Click **Stop** if you would like to end the test before it completes all the selected measurements.

Test Failures

When a test fails, it is most often due to configuration problems: you may have forgotten to specify a driver control, or selected a balanced XLR input for your instrument but connected the input cable to the unbalanced BNC. In many cases a PC Audio Test dialog box will open with a description of the error and a recommended solution. If you have a failure that is not easily solved, check for more information in Appendix A, **Troubleshooting**.

PLAY Measurement Path

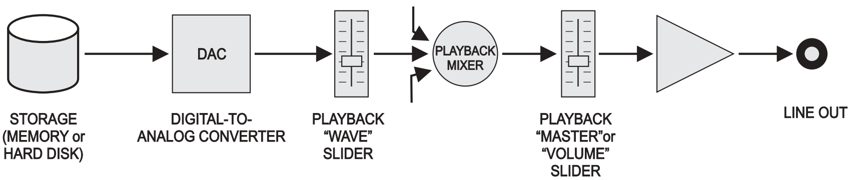


Figure 34. PLAY path block diagram.

Introduction to PLAY (PC-D-A path)

In PLAY, the PC sound device normally reads a digital audio file from the PC disk storage or memory, converts the audio to an analog signal using a DAC (digital-to-analog converter), amplifies, conditions and routes the signal to the Line Out analog output jacks.

The driver software controlling the PC sound device provides a Playback mixer with a volume control for this path, usually called the "Wave" slider. Additionally, there is often a second "Master" or "Volume" control slider. Other PLAY sliders and features may be provided.

NOTE: For testing purposes, all other PLAY mixer sliders must be muted; balance and EQ or tone controls, if any, must be set to their neutral positions, and all effects such as Surround, Reverb or Wide Stereo must be disabled.

Stimulus signals for the PLAY path

For single-tone PLAY measurements, PC Audio Test inserts the appropriate digital stimulus signal into the PC. The DUT "plays" this signal as if it were a wave file from the PC's hard disk. For multitone measurements (used in frequency and phase response measurements), a multitone wave file that has been prerecorded onto the PC's hard disk during installation is played by the DUT.

Level Reference measurement (Do this FIRST!)

See the Level Reference sidebar on page 38.

The PLAY Level Reference measurement is used as the level reference for all other analog measurements made by PC Audio Test.

Level Reference

Audio testing almost always begins by establishing a reference level, usually a mid-band frequency and often at or near the maximum operating level of a device. This level is used as the reference for test results that are expressed in relative terms, such as distortion, dynamic range or frequency response. In record/playback systems, the level produced when a reference recording is played is also used as the reference for the playback of a recorded signal.

For digital work, the mid-range frequency is usually chosen to be 997 Hz, which is close to the 1000 Hz used in analog testing but is non-synchronous with standard sample rates. This ensures that the converter under test will be exercised through a maximum number of its possible states.

Maximum level in a digital system can be defined in a number of ways; for PC sound devices maximum digital level is usually considered to be either:

- *0 dBFS or*
- *the highest level that produces less than 1% THD+N.*

0 dBFS means "zero decibels full scale." 0 dBFS is defined as the level at which the positive and negative peaks of a sine wave just touch the maximum numerical values available in the coding system. For 16-bit PCM, these peak values in decimal two's complement are 32767 and –32768. 0 dBFS is the maximum level at which a sine wave can be recorded without digital overload.

NOTE: Many PC audio devices limit the audio input to the ADC to prevent audio overload. With such devices it is impossible to attain 0 dBFS in recording, and a somewhat lower maximum level must be specified. This reduced level reference can vary from model to model.

1% THD+N means "one percent total-harmonic-distortion-plus-noise," often simply called 1% distortion. Most digital devices have distortion well below one percent except near digital overload, and this alternate statement of maximum level can provide a reference near 0 dBFS.

NOTE: Some PC audio devices have very low distortion right up to digital overload, and never exhibit 1% distortion. Some poorly designed devices exhibit distortion higher than 1% throughout much of their range. In either case, determining a reference level by finding the 1% distortion point can be very difficult.

Other levels below 0 dBFS (such as –1 dBFS, –3 dBFS, –6 dBFS and so on) can be specified for certain standards and tests.

For PLAY Level Reference, PC Audio Test inserts the appropriate digital stimulus signal into the PC for DUT playback. This signal is a 997 Hz sine wave at a standard level (normally 0 dBFS). See PLAY Level Reference Settings on page 23.

PC Audio Test sets the DUT playback mixer master volume slider to its maximum, and adjusts the wave slider to find the step just below that which produces 1% (–40 dB) THD+N at the DUT outputs. If the THD+N is below 1% at any wave slider setting, the wave slider is set to its maximum setting.

PLAY Level Reference

PC Audio Test then measures the signal voltages appearing at the DUT outputs. These voltages, usually expressed in dBV units, are used as the analog voltage level references for all PC Audio Test measurements within a particular DUT.

<DAFSLvlAr>
<DAFSLvlBr>

These amplitudes are set as the instrument analyzer references, 0 dBr$_{(\text{PLAY})}$ (A and B). PC Audio Test refers to them as the PLAY Level References. In PCAQM these references are called FSOV (Full Scale Output Voltage) for channels A and B.

0 dBr A – 0 dBr B

FSOV A & B

Do PLAY Level Reference FIRST!

NOTE: PLAY path Level Reference ***must*** *be determined before any other measurements can be made. Even if you are performing a reduced set of measurements for your DUT test, you will find that PC Audio Test will always direct you to perform the PLAY path Level Reference measurement first.*

Sample Rate Error

PLAY Sample Rate Error

<DASRateErr>

The stimulus signal that is inserted into the DUT for PLAY Level Reference is produced by the instrument digital generator at precisely 997.001 Hz. The frequency of the DUT output is measured and compared to this value. Any variation is due to sample rate error in the DUT DAC clock reference. The variation is reported as a percentage.

THD+N at PLAY Level Reference

PLAY THD+N @ Level Ref

<DAFSTHDA>
<DAFSTHDB>

After the Level Reference has been set, the same 997 Hz tone is analyzed for its distortion as part of the PLAY Level Reference measurement. The distortion is measured as unweighted THD+N (total harmonic distortion plus noise) across a bandwidth of 10 Hz to 22 kHz. This reading usually differs from the results in the PLAY THD+N measurement discussed below due to possible differences in stimulus level and filtering.

Playback Mixer Wave slider position

PB Mixer Wave Slider position

<WAVOutSlider>

PC Audio Test reads the playback mixer Wave slider position at PLAY Level Reference. The position is reported as a step number.

See the **Slider Position** sidebar on page 41.

Playback Mixer Master (Volume) slider position

PB Mixer Master Slider position

<MasterSlider>

PC Audio Test reads the playback mixer Master (Volume) slider position at PLAY Level Reference. The position is reported as a step number.

See the **Slider Position** sidebar on page 41.

PLAY THD+N

<DATHDA>
<DATHDB>

THD+N measurement

See the Distortion (THD+N) sidebar on page 44.

For the PLAY THD+N measurement, PC Audio Test inserts the appropriate digital stimulus signal into the PC for DUT playback. The THD+N stimulus is always a 997 Hz sine wave. Depending on your configuration settings, the stimulus level may be at 0 dBFS, –1 dBFS, –3 dBFS, –6 dBFS or at a level of your choice. AES17 specifies the –1 dBFS stimulus level; WHQL PC2001 specifies –3 dBFS.

The DUT analog output is analyzed for THD+N. As an option, you can apply an analyzer weighting or bandpass filter; if a THD+N measurement is filtered, it is typically with a bandpass filter. WHQL, however, specifies a weighting filter.

The filter must be installed and available in your Audio Precision instrument. See **Test Settings** in Chapter 2 for more information on applying filters to the THD+N measurements.

NOTE: In accordance with accepted practice for PC sound device measurements, PC Audio Test expresses THD+N results relative to the PLAY Level Reference rather than to the stimulus tone level.

PLAY Dynamic Range

<DADynRngA>
<DADynRngB>

Dynamic Range measurement

See the Dynamic Range sidebar on page 48.

For the PLAY Dynamic Range measurement, PC Audio Test inserts a stimulus signal into the PC for DUT playback. The dynamic range stimulus is a 997 Hz sine wave at a very low level that prevents the DAC from muting. This tone is typically set to –60 dBFS. The tone is removed by a narrow notch filter in the analyzer before the residue is measured.

You can also apply an analyzer weighting or bandpass filter to the Dynamic Range measurement; if a Dynamic Range measurement is filtered, it is typically with a weighting filter.

The filter must be installed and available in your Audio Precision instrument. See **Test Settings** in Chapter 2 for more information on applying filters to the Dynamic Range measurements.

PLAY Frequency Response

<DAResponse>

PLAY Frequency vs Relative Phase

Frequency Response measurement

See the Frequency Response sidebar on page 53.

For the PLAY Frequency Response measurement, PC Audio Test uses a multitone technique. A set of multitone files were installed on the target PC during installation, and PC Audio Test plays the appropriate file for your test.

NOTE: You can specify a custom multitone file for frequency response testing. Custom multitone files can be created using the Audio Precision Multitone Creation utility or by downloading files from the Audio Precision Web site at audioprecision.com. See Frequency Response Settings on page 26.

The multitone in the DUT analog output signal is analyzed in your Audio Precision instrument using FFT techniques, resulting in a graph showing both frequency and phase response.

Passband Ripple measurement

PLAY Passband Ripple

<DARipple>

See the Passband Ripple sidebar on page 55.

A second multitone and second FFT analysis are automatically performed during the PLAY Frequency Response measurements. These results are smoothed and subjected to Compute calculations, providing a Passband Ripple measurement of the DUT's DAC. The Passband Ripple results are displayed as a graph on a linear scale.

Slider Position

Volume sliders in a PC audio device control the signal volume in discrete steps. A slider may have 32 steps, 256 steps or more. These sliders can control DSP gain algorithms, or dedicated hardware gain circuits in the PC audio device.

The gain mechanisms may follow the slider steps in a linear manner, or logarithmically or follow some other gain law. This range of characteristics can make automated gain adjustment difficult.

PC Audio Test can correctly find the correct slider position for device testing successfully most of the time. If unusual DUT characteristics makes this difficult, you can enter a fixed slider position for the volume sliders associated with a measurement path in the DUT configuration panel.

Whether automatically located or manually entered, the associated slider position for each measurement is recorded and listed in the test results. Slider position is always reported as a step number, not a decibel value.

ANALOG LOOP Measurement Path

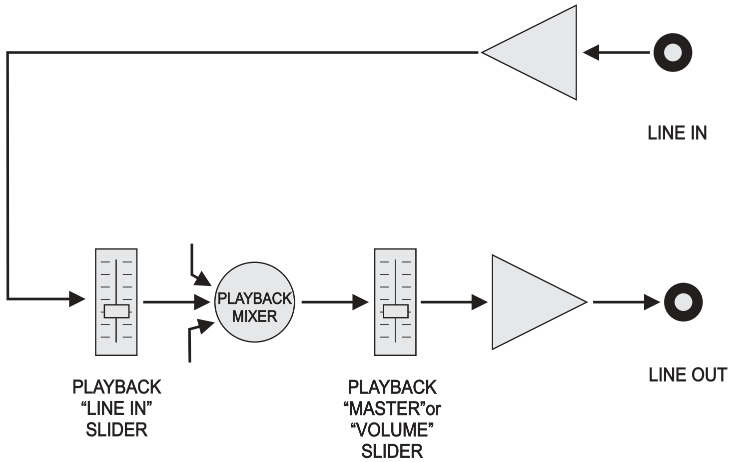


Figure 35. ANALOG LOOP path block diagram.

Introduction to ANALOG LOOP (A-A path)

In ANALOG LOOP, the PC audio device buffers and sets the level of the analog audio presented at the Line input, and then routes the signal through the playback mixer and to the device analog outputs. If there is no Line Input, the MIC ANALOG LOOP must be used.

Stimulus signals for the ANALOG LOOP path

For both single-tone and multitone ANALOG LOOP measurements, PC Audio Test controls the instrument analog generator, providing the appropriate analog stimulus signal for each measurement.

Level Reference measurement

The ANALOG LOOP Level Reference is the output voltage measured at the analog outputs when the ANALOG LOOP path Level Reference criteria are satisfied. See the Level Reference sidebar on page 38.

Unity Gain Setting

It is possible to measure ANALOG LOOP Level Reference under two conditions: with unity gain forced (the default PC Audio Test setting) and without unity gain forced. See Test Settings on page 22.

dBr

Audio Precision instruments use a unit called the dBr as a reference for relative measurements.

For the instrument generator, the reference is the same for both output channels and is designate dBr. PC Audio Test calls this reference $dBr_{(REC)}$.

For the instrument analyzer, there is a reference for each input channel: dBr A and dBr B. PC Audio Test calls these references $dBr_{(PLAY)}$.

For PC Audio Test measurements, the voltage level measured in the PLAY mode level reference measurement defines 0 dBr for all the other measurements within the test. Once defined by the level reference measurement, then,

$$0\ dBFS = 0\ dBr_{(PLAY)}.$$

Unity Gain forces the ANALOG LOOP measurements to be performed under the assumption that a given input voltage at a channel line input will produce the same voltage at the channel line output, and that the DUT is designed to accommodate unity gain operation with good performance at a reasonable mixer slider volume setting.

Level Reference with Unity Gain selected (default)

ANLG LOOP Level Reference

<AAFSLvlA>
<AAFSLvlB>

0 dBr $A_{(PLAY)}$
0 dBr $B_{(PLAY)}$

ANLG LOOP Unity Gain Error

<AAUnityGainErrA>
<AAUnityGainErrB>

To establish the ANALOG LOOP Level Reference, PC Audio Test applies a 997 Hz sine wave to the DUT Line Input at the voltage that corresponds to –20 dBr $A_{(PLAY)}$. The playback mixer Line In volume slider is adjusted until the voltage at the Line Out A jack is the same (–20 dBr $A_{(PLAY)}$).

NOTE: The step resolution of mixer sliders is often coarse, and it is usually not possible to adjust the slider so that the Line Out voltage exactly equals the Line In voltage. PC Audio Test finds the slider setting that produces the closest result, and then reports the difference due to slider resolution as the Unity Gain Error.

Next, PC Audio Test adjusts the instrument analog generator to find the point just below that which produces 1% THD+N at the Line Out jack. The voltage at the Line Out jack is measured and reported as the ANALOG LOOP Level Reference. The generator voltage is measured and reported as the DUT Input Level.

Level Reference with Unity Gain deselected

There may be circumstances where DUT characteristics or measurement specifications do not allow a forced unity gain condition. In that case, deselect Unity Gain on the Test Settings panel.

With Unity Gain deselected, PC Audio Test searches for the signal that can be applied to the Line In jacks while producing less than 1% THD+N at the

Output jacks, for any mixer Line In volume slider setting. The voltage at the Line Out jack is measured and reported as the ANALOG LOOP Level Reference. The generator voltage is measured and reported as the DUT Input Level.

ANLG LOOP THD+N @ Level Reference

<AAFSTHDA>
<AAFSTHDB>

THD+N at ANALOG LOOP Level Reference

After the Level Reference has been set, the same 997 Hz tone is analyzed for its distortion as part of the ANALOG LOOP Level Reference measurement. The distortion is measured as unweighted THD+N (total harmonic distortion plus noise) across a bandwidth of 10 Hz to 22 kHz. This reading usually differs from the results in the ANALOG LOOP THD+N measurement discussed below due to possible differences in stimulus level and filtering.

ANLG LOOP Line In Level

<AAInLvlrA>
<AAInLvlB>

Line In Level measurement

With the ANALOG LOOP Level Reference set and measured, PC Audio Test measures the instrument generator output level, which is the level applied to the DUT Line Inputs. This measurement is the ANALOG LOOP Line In Level.

PB mixer Line In Slider position

<LineMonOutSlider>

Line In Slider setting

PC Audio Test reads the playback mixer Line In slider position at ANALOG LOOP Level Reference. The position is reported as a step number.

See the **Slider Position** sidebar on page 41.

Distortion (THD+N)

There are many ways to distort an audio signal, but in this sidebar we will only consider harmonic distortion. Harmonic distortion occurs under conditions of non-linearity (usually due to overload) in a device, and is characterized by the presence in the output signal of integer multiples of the stimulus frequency, or harmonics. These harmonics can be primarily even harmonics (x2, x4, etc), primarily odd harmonics (x3, x5, etc.) or a mixture of both. The amplitudes of the harmonics generally decrease with frequency.

For many purposes, the amplitude of the third harmonic is sufficient to characterize the distortion. This third-order harmonic (or third harmonic) distortion is expressed in relation to the stimulus signal as a percentage (or ratio, usually in decibels).

In other cases, the total of the amplitudes of all the measured harmonics is required. This total harmonic distortion, or THD, is expressed in relation to the stimulus signal as a percentage (or ratio, usually in decibels). Since the residual noise of a device is usually at a very low amplitude compared to the distortion (and is not easily removed from the results), this measurement is generally performed to give total harmonic distortion plus noise, or THD+N.

Note that distortion is generally expressed as a ratio or percentage of the stimulus signal. The standards that define PC audio device testing procedures, however, state the distortion as a ratio or percentage of 0 dBFS, even if the stimulus has a lower amplitude. This approach provides results that may be at variance with traditional distortion measurement techniques.

THD+N measurement

ANLG LOOP THD+N

<AATHDA>
<AATHDB>

See the Distortion (THD+N) sidebar on page 44.

For the ANALOG LOOP THD+N measurement, PC Audio Test applies a 997 Hz sine wave to the Line In jacks. Depending on your configuration settings, the stimulus level may be at 0 dB, –1 dB, –3 dB, –6 dB, or at a level of your choice, relative to the DUT Analog Input Level. AES17 specifies the –1 dB stimulus level; WHQL PC2001 specifies –3 dB.

The DUT analog output is analyzed for THD+N. As an option, you can apply an analyzer weighting or bandpass filter; if a THD+N measurement is filtered, it is typically with a bandpass filter. WHQL, however, specifies a weighting filter.

The filter must be installed and available in your Audio Precision instrument. See **Test Settings** in Chapter 2 for more information on applying filters to the THD+N or Dynamic Range measurements.

NOTE: In accordance with accepted practice for PC sound device measurements, PC Audio Test expresses THD+N results relative to the PLAY Level Reference rather than to the stimulus tone level.

Dynamic Range measurement

ANLG LOOP Dynamic Range

<AADynRngA>
<AADynRngB>

See the Dynamic Range sidebar on page 48.

For the ANALOG LOOP Dynamic Range measurement, PC Audio Test applies a 997 Hz sine wave at a very low level to the Line Input jacks. This tone is typically set to –60 dB relative to the DUT Analog Input Level.

In the PLAY Dynamic Range measurement (see page 40), the purpose of the –60 dB signal was to keep the DAC from muting. Although there is no DAC in the ANALOG LOOP path, the –60 dB signal (and the analyzer notch filter to remove it) is used so that this measurement will be comparable to the PLAY THD+N measurement.

You can also apply an analyzer weighting or bandpass filter to the Dynamic Range measurement; if a Dynamic Range measurement is filtered, it is typically with a weighting filter.

The filter must be installed and available in your Audio Precision instrument. See **Test Settings** in Chapter 2 for more information on applying filters to the THD+N measurements.

Signal-to-Noise Ratio measurement

ANLG LOOP SNR

This Signal-to-Noise Ratio (SNR) measurement is unique to the ANALOG LOOP paths (both Line In and Mic In).

<AASNRA>
<AASNRB>

It is similar to the ANALOG LOOP Dynamic Range measurement, but does not use a low-level tone for stimulus, or an analyzer notch in measurement. Instead, the broadband noise at the Line Out jacks is measured and expresses as a ratio to the ANALOG LOOP Level Reference.

Like the THD+N and Dynamic Range measurements, you can apply a weighting or bandpass filter to the SNR measurement; if an SNR measurement is filtered, it is typically with a weighting filter.

The filter must be available in your Audio Precision instrument. The Dynamic Range filter selection is used as the selection for filtering SNR measurements. See **Test Settings** in Chapter 2 for more information on applying filters to the Dynamic Range and SNR measurements.

NOTE: Due to the absence of a notch filter in the SNR measurement, the results may vary slightly from the Dynamic Range results.

Frequency Response measurement

ANLG LOOP Frequency Response

<AAResponse>

See the Frequency Response sidebar on page 53.

For the ANALOG LOOP Frequency Response measurement, PC Audio Test uses a multitone technique. PC Audio Test causes your Audio Precision instrument analog generator to output an appropriate multitone file for your test.

NOTE: You can specify a custom multitone file for frequency response testing. Custom multitone files can be created using the Audio Precision Multitone Creation utility or by downloading files from the Audio Precision Web site at audioprecision.com. See Frequency Response Settings on page 26.

ANLG LOOP Frequency vs. Phase

The multitone in the DUT analog output signal is analyzed in your instrument using FFT techniques, resulting in a graph showing both frequency and phase response.

Crosstalk measurement

ANLG LOOP Crosstalk

<AAXtlkA-B>
<AAXtlkB-A>

The Crosstalk measurement is unique to the ANALOG LOOP path.

For the ANALOG LOOP Crosstalk measurement, PC Audio Test applies a 10 kHz sine wave at reference level first on Channel A, then on Channel B. During each period of stimulus, the output of the opposite channel is measured through a 10 kHz one-third octave bandpass filter to determine the level of channel-to-channel crosstalk or “bleed through” occurring in the DUT.

Crosstalk is expressed as the ratio of the measured crosstalk level to the stimulus level, in decibels.

MIC ANALOG LOOP Measurement Path

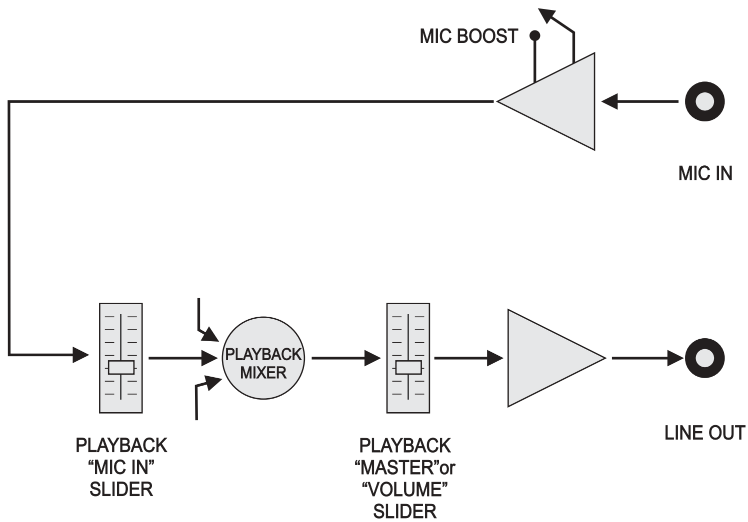


Figure 36. MIC ANALOG LOOP path block diagram.

Introduction to MIC ANALOG LOOP (A-A (mic) path)

MIC ANALOG LOOP is an alternate ANALOG LOOP path for PC audio devices that have no line inputs, such as those found on most notebook PC implementations. The measurements are similar to those in ANALOG LOOP, with the addition of a few Mic In specific measurements.

In MIC ANALOG LOOP, the PC audio device buffers and sets the level of the analog audio presented at the Mic input, and then routes the signal through the playback mixer and to the device analog outputs. Mic Boost gain and microphone bias voltage and current are measured.

Using the Mic Bias cable

Most PC audio devices with a 3.5 mm Mic In jack provide a monaural (single-channel) microphone input with a bias current available to power electret condenser microphones. The Mic Bias cable provided with PC audio test enables you to test the audio performance and measure the mic bias voltage without re-patching interconnections. We recommend you use this cable for MIC ANALOG LOOP testing on PC audio devices fitted with a 3.5 mm mic jack wired for mic bias current.. See **Mic Bias measurements**, below.

Dynamic Range

A dynamic range measurement for a PC audio device is essentially a signal-to-noise ratio measurement: it provides the ratio between the maximum level possible in the device to the level of the residual noise of the device. Like a signal-to-noise measurement, the device output is often filtered with bandpass or weighting filters to provide meaningful or comparable results. Any filtering applied must be acknowledged with the results.

There is a key difference in performing a dynamic range measurement on a device that uses a DAC in its processing: most DACs mute their output when the digital signal falls to a very low level. This provides an unrealistically low level of residual noise, since the output is not the noise of the system but the output of a muted DAC. This noise measurement with the DAC muted is called the Idle Channel Noise measurement.

To prevent this muting, dynamic range tests for PC audio devices use a low-level stimulus tone to keep the DAC in an unmuted condition. This tone is removed before measurement using a notch filter, and is set to a low enough value that any components of harmonic distortion that may be generated in the device will be of a level well below the residual noise level and therefore unmeasurable. This technique provides a true dynamic range value for the device in an unmuted condition.

A stimulus tone of 997 Hz at –60 dBr$_{(REC)}$*. (–60 dBFS in a normally referenced test) is specified for PC audio devices of 16-bit resolution.*

For consistency, PC Audio Test measurements that do not include a DAC (RECORD and the ANALOG LOOP paths) use the same –60 dBr tone in the stimulus signal and notch filter in the analysis.

Stimulus signals for the MIC ANALOG LOOP path

For both single-tone and multitone MIC ANALOG LOOP measurements, PC Audio Test controls the instrument analog generator, providing the appropriate analog stimulus signal for each measurement.

MIC LOOP Level Reference

Level Reference measurement

The MIC ANALOG LOOP Level Reference is the output voltage measured at the analog outputs when the MIC ANALOG LOOP path Level Reference criteria are satisfied. See the Level Reference sidebar on page 38.

<AAMicFSLvlA>
<AAMicFSLvlB>

PC Audio Test searches for the signal that can be applied to the Mic In jack while producing less than 1% THD+N at the Output jacks, for any mixer Mic In volume slider setting. The voltage at the Line Out jack is measured and reported as the MIC ANALOG LOOP Level Reference.

MIC LOOP THD+N @ Level Reference

<AAMicFSTHDA>
<AAMicFSTHDB>

THD+N at MIC ANALOG LOOP Level Reference

After the Level Reference has been set, the same 997 Hz tone is analyzed for its distortion as part of the MIC ANALOG LOOP Level Reference measurement. The distortion is measured as unweighted THD+N (total harmonic distortion plus noise) across a bandwidth of 10 Hz to 22 kHz. This reading usually differs from the results in the MIC ANALOG LOOP THD+N measurement discussed below due to possible differences in stimulus level and filtering.

Mic In Level measurement

MIC LOOP Line In Level

<AAMicInLvlrA>

With the MIC ANALOG LOOP Level Reference set and measured, PC Audio Test measures the instrument generator output level, which is the level applied to the DUT Line Inputs. This measurement is the MIC ANALOG LOOP Line In Level.

Mic In Slider setting

PB mixer Mic In Slider position

<MicInSlider>

PC Audio Test reads the playback mixer Mic In slider position at MIC ANALOG LOOP Level Reference. The position is reported as a step number.

See the **Slider Position** sidebar on page 41.

Mic Boost Gain measurement

Mic In Boost Gain

<AABoostGain>

The channel gain is measured with Mic Boost both ON and OFF, and the difference is reported in dB as the Mic Boost Gain.

Mic In Gain Max

<AAMaxMicGain>

The maximum gain available in the mic channel with Mic Boost ON is reported in dB as Mic In Gain Maximum.

Mic Bias measurements

Mic In Bias Voltage

<MicInSupplyV>

Most PC audio devices with a mono Mic input on a 3.5 mm jack provide a bias current to power those microphones that require bias. The Mic In jack is wired with the microphone input on the tip connection, and the microphone

Signal-to-Noise Ratio (SNR)

Also see the Dynamic Range sidebar on the previous page.

Due to converter muting, the Dynamic Range measurement is usually chosen for noise measurements in digital devices. However, since there are no converters in the ANALOG LOOP paths, the SNR measurement can also be used.

SNR measurements are made with no stimulus signal, and the device input shorted or terminated in a typical source impedance. The device output signal (often filtered with a weighting filter) is applied to a broadband audio meter, and this value is compared to the reference level and expressed as a ratio. Results of this measurement will usually differ from Dynamic Range results due to the effect of the notch filter used in that technique.

Most PC audio devices have relatively high-impedance inputs, and the level of the device output noise can vary greatly with changes in input source impedance. With an Audio Precision generator connected to the input (but with no signal applied) the source impedance presented to the DUT is 40 Ω balanced and 20 Ω unbalanced. Higher source impedances may degrade SNR results. When SNR is measured using the Mic input, care must be taken to minimize cable noise and pickup of spurious signals in the input connections.

Mic In Bias Current

<MicInSupplyI>

bias current available on the ring connection. In addition to testing the Mic In audio performance, PC Audio Test can measure both the bias voltage and the bias current under conditions comparable to a nominal load.

This is made easy using the Mic Bias cable provided with PC Audio Test. The Mic Bias cable provides a female XLR for connection to the Audio Precision instrument Analog Output, and a male XLR for connection to the instrument Analog Input for Mic Bias measurement. See page 30 and Figure 37, below.

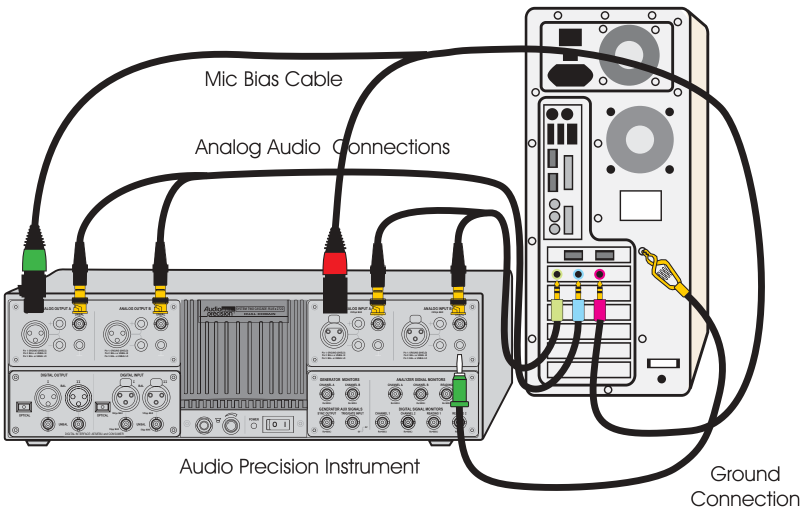


Figure 37. Connections for MIC ANALOG LOOP with Mic Bias cable..

MIC LOOP THD+N

<AAMicTHDA>
<AAMicTHDB>

THD+N measurement

See the Distortion (THD+N) sidebar on page 44.

For the MIC ANALOG LOOP THD+N measurement, PC Audio Test applies a 997 Hz sine wave to the Line In jacks. Depending on your configuration settings, the stimulus level may be at 0 dB, –1 dB, –3 dB, –6 dB, or at a level of your choice, relative to the DUT Analog Input Level. AES17 specifies the –1 dB stimulus level; WHQL PC2001 specifies –3 dB.

The DUT analog output is analyzed for THD+N. As an option, you can apply an analyzer weighting or bandpass filter; if a THD+N measurement is filtered, it is typically with a bandpass filter. WHQL, however, specifies a weighting filter.

The filter must be installed and available in your Audio Precision instrument. See **Test Settings** in Chapter 2 for more information on applying filters to the THD+N measurements.

NOTE: In accordance with accepted practice for PC sound device measurements, PC Audio Test expresses THD+N results relative to the PLAY Level Reference rather than to the stimulus tone level.

Dynamic Range measurement

MIC LOOP Dynamic Range

<AAMicDynRngA>
<AAMicDynRngB>

See the Dynamic Range sidebar on page 48.

For the MIC ANALOG LOOP Dynamic Range measurement, PC Audio Test applies a 997 Hz sine wave at a very low level to the Line Input jacks. This tone is typically set to –60 dB relative to the DUT Analog Input Level.

In the PLAY Dynamic Range measurement (see page 40), the purpose of the –60 dB signal was to keep the DAC from muting. Although there is no DAC in the ANALOG LOOP path, the –60 dB signal (and the analyzer notch filter to remove it) are used so that this measurement will be comparable to the PLAY THD+N measurement.

You can also apply a weighting or bandpass filter to the Dynamic Range measurement. The filter must be available in your Audio Precision instrument. See Test Settings in Chapter 2 for more information on applying filters to the Dynamic Range measurements.

Signal-to-Noise Ratio measurement

MIC LOOP SNR

<AAMicSNRA>
<AAMicSNRB>

This Signal-to-Noise Ratio (SNR) measurement is unique to the ANALOG LOOP paths (both Line In and Mic In).

It is similar to the MIC ANALOG LOOP Dynamic Range measurement, but does not use a low-level tone for stimulus, or an analyzer notch in measurement. Instead, the broadband noise at the Line Out jacks is measured and expresses as a ratio to the MIC ANALOG LOOP Level Reference.

Like the THD+N and Dynamic Range measurements, you can apply a weighting or bandpass filter to the SNR measurement; if an SNR measurement is filtered, it is typically with a weighting filter.

The filter must be available in your Audio Precision instrument. The Dynamic Range filter selection is used as the selection for filtering SNR measurements. See **Test Settings** in Chapter 2 for more information on applying filters to the Dynamic Range and SNR measurements.

NOTE: Due to the absence of a notch filter in the SNR measurement, the results may vary slightly from the Dynamic Range results.

ANLG LOOP Frequency Response

<AAMicResponse>

Frequency Response measurement

See the Frequency Response sidebar on page 53.

For the MIC ANALOG LOOP Frequency Response measurement, PC Audio Test uses a multitone technique. PC Audio Test causes your Audio Precision instrument analog generator to output an appropriate multitone file for your test.

NOTE: You can specify a custom multitone file for frequency response testing. Custom multitone files can be created using the Audio Precision Multitone Creation utility or by downloading files from the Audio Precision Web site at audioprecision.com. See Frequency Response Settings on page 26.

MIC LOOP Frequency vs. Phase

The multitone in the DUT analog output signal is analyzed in your instrument using FFT techniques, resulting in a graph showing both frequency and phase response.

RECORD Measurement Path

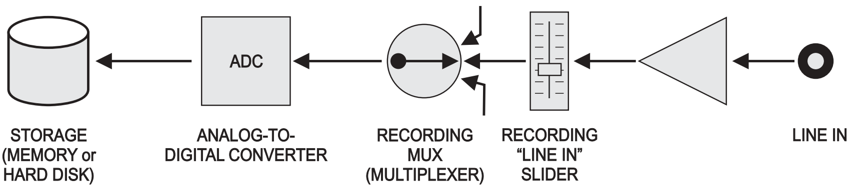


Figure 38. RECORD path block diagram.

Introduction to RECORD (A-D-PC path)

In RECORD, the PC audio device buffers and sets the level of the analog audio presented at the Line input, converts it to a digital audio signal using the audio device ADC (analog-to-digital converter), and stores the audio as a Wave file in PC memory or disk storage.

The driver software communicating with the sound device provides a Record mixer with a volume control for this path, usually called the Line In slider control. Other recording sliders may be provided, but in most cases the recording multiplexer allows selection of only one at a time. In some DUTs, the recording multiplexer Line In volume and the playback mixer Line In volume are addressed by the same slider control.

Frequency Response

Frequency response is one of the most common and telling audio measurements. Conventional frequency response measurements use as a stimulus a series of single frequency tones spaced across the passband, or a continuous sweep of frequencies, swept from one end of the passband to the other. The output of the DUT is measured at each frequency of interest, and the level measured is plotted against frequency to produce as response graph or curve. The maximum deviations are commonly measured from a nominal mid-band frequency, often 1 kHz, and the response is given as a graph or as a statement of deviation, such as ± 2 dB, 20 Hz–20 kHz.

Audio Precision uses an alternative multitone *technique for PC Audio Test frequency response (and passband ripple response) measurements. In a multitone measurement, a special stimulus signal is created in digital signal processing that contains all the frequencies of interest, at precisely known levels and frequencies. This signal is applied (as an analog or digital signal, as necessary) to the DUT, and the output of the DUT is analyzed using FFT techniques. This approach provides very fast, precise measurements of both frequency and phase response at the multitone frequencies.*

Stimulus signals for the RECORD path

For both single-tone and multitone RECORD measurements, PC Audio Test controls the instrument analog generator, providing the appropriate analog stimulus signal for each measurement.

Level Reference measurement

See the Level Reference sidebar on page 38.

The RECORD Level Reference measurement is used as the level reference for recording measurements made by PC Audio Test.

NOTE: You must perform this measurement before other RECORD or RECORD/PLAY LOOP path measurements.

RECORD Level Reference

<ADFSLvlA>
<ADFSLvlB>

To establish the RECORD Level Reference, PC Audio Test applies a 997 Hz sine wave to the DUT Line Input, sets the DUT record multiplexer Line In slider to the ANALOG LOOP reference setting (if available; otherwise, it is set to the center of its range), and varies the level of the applied signal to locate the level one step below the level that produces 1% THD+N in the DUT output. This point is considered to be 0 dBFS. See RECORD Level Reference Settings on page 24.

0 dBr $A_{(REC)}$
0 dBr $B_{(REC)}$

This amplitude is set as the instrument generator reference, which PC Audio Test refers to as the RECORD Level Reference, or 0 dBr $_{(REC)}$.

Do RECORD Level Reference FIRST!

RECORD Level Reference **must** be determined before any other recording measurements involving the analog inputs (RECORD, RECORD/PLAY LOOP) can be made.

Rec mixer Line In Slider position

<LineInSlider>

Line In (Recording) Slider setting

PC Audio Test reads the recording mixer Line In slider position at RECORD Level Reference. The position is reported as a step number.

See the **Slider Position** sidebar on page 41.

THD+N measurement

See the Distortion (THD+N) sidebar on page 44.

REC THD+N

<ADTHDA>
<ADTHDB>

For the RECORD THD+N measurement, PC Audio Test applies a 997 Hz sine wave to the DUT Line Input at a nominal amplitude. The THD+N stimulus is always a 997 Hz sine wave. Depending on your configuration settings, the stimulus level may be at 0 dBr $_{(REC)}$, –1 dBr $_{(REC)}$, –3 dBr $_{(REC)}$,

Passband Ripple

Passband ripple refers to the series of minor peaks and valleys observed in the passband frequency response of an ADC or DAC. This response ripple is a function of converter design, and in most modern converters the ripple amplitude is negligible, typically small fractions of a decibel.

The passband ripple measurement is performed in a similar way to the frequency response measurement. A multitone signal (although a different multitone) is the stimulus, and the DUT output is analyzed for response using FFT techniques.

However, the ripple component must be extracted from the raw response curve to create a useful plot, and this is accomplished by FFT smoothing and then removing the converter response slope from the measurement using analyzer Compute functions.

Since the ripples in the passband appear in a linear relationship to frequency, the tones in the multitone stimulus are set in an approximately linear spacing. The tones in the frequency response multitone are logrithmically spaced.

–6 dBr $_{(REC)}$ or at a level of your choice. AES17 specifies the –1 dB stimulus level; WHQL PC2001 specifies –3 dB.

The DUT ADC output is acquired directly within the PC and analyzed for THD+N using FFT techniques. Since the instrument Analog Analyzer cannot be used for this measurement, the weighting or bandpass filters are not available for THD+N measurements in the RECORD path.

In accordance with accepted practice for PC sound device measurements, PC Audio Test expresses THD+N results relative to the RECORD Level Reference rather than to the stimulus tone level.

Dynamic Range measurement

See the Dynamic Range sidebar on page 48.

RECORD Dynamic Range

<ADDynRangA>
<ADDynRangB>

For the RECORD path dynamic range measurement, PC Audio Test applies a 997 Hz sine wave at a very low level to the Line Input jacks. This tone is typically set to –60 dB relative to the DUT Analog Input Level.

The DUT ADC output is acquired directly within the PC and analyzed for dynamic range, referenced to 0 dBFS.

Frequency Response measurement

See the Frequency Response sidebar on page 53.

RECORD Frequency Response

<ADResponse>

For the RECORD Frequency Response measurement, PC Audio Test uses a multitone technique. An appropriate multitone signal is applied to the DUT Line Input at a nominal level. Depending on your configuration settings, the stimulus level may be at 0 dBr $_{(REC)}$, –1 dBr $_{(REC)}$, –3 dBr $_{(REC)}$, –6 dBr $_{(REC)}$ or at a level of your choice.

NOTE: You can specify a custom multitone signal for frequency response testing. Custom multitone signals can be created using the Audio Precision Multitone Creation utility or by downloading files from the Audio Precision Web site at audioprecision.com. See Frequency Response Settings on page 26.

The multitone signal in the DUT ADC output is acquired directly within the PC and is analyzed using FFT techniques, resulting in a graph showing both frequency and phase response.

Passband Ripple measurement

See the Passband Ripple sidebar on page 55.

RECORD Passband Ripple

<ADRipple>

A second multitone and second FFT analysis are automatically performed during the RECORD Frequency Response measurements. These results are smoothed and subjected to Compute calculations to remove response variations, providing a Passband Ripple measurement of the DUT's ADC. The Passband Ripple results are displayed as a graph on a linear scale.

MIC RECORD Measurement Path

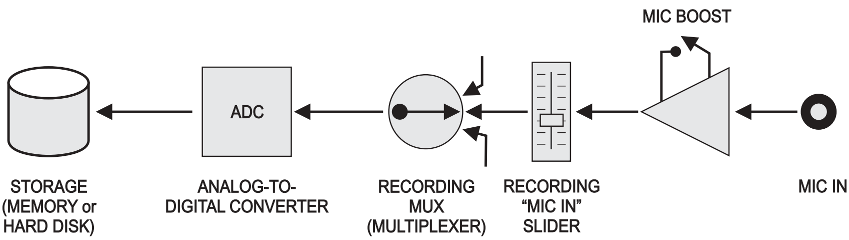


Figure 39. MIC RECORD path block diagram.

Introduction to MIC RECORD (A-D-PC path)

In MIC RECORD, the PC audio device buffers and sets the level of the analog audio presented at the Mic input, converts it to a digital audio signal using the audio device ADC (analog-to-digital converter), and stores the audio as a Wave file in PC memory or disk storage.

The driver software communicating with the sound device provides a Record mixer with a volume control for this path, usually called the Mic In slider control. Other recording sliders may be provided, but in most cases the recording multiplexer allows selection of only one at a time. In some DUTs, the recording multiplexer Mic In volume and the playback mixer Mic In volume are addressed by the same slider control.

You may choose to engage the audio device Mic Boost if you wish. The MIC RECORD tests will proceed normally, but the results will be noisier by the amount of gain applied by the device's Mic Boost feature.

Stimulus signals for the MIC RECORD path

For both single-tone and multitone MIC RECORD measurements, PC Audio Test controls the instrument analog generator, providing the appropriate analog stimulus signal for each measurement.

Level Reference measurement

See the Level Reference sidebar on page 38.

The MIC RECORD Level Reference measurement is used as the level reference for recording measurements made by PC Audio Test.

NOTE: You must perform this measurement before other MIC RECORD or RECORD/PLAY LOOP path measurements.

MIC RECORD Level Reference

<MicADFSLvlA>
<MicADFSLvlB>

To establish the MIC RECORD Level Reference, PC Audio Test applies a 997 Hz sine wave to the DUT Mic Input, sets the DUT record multiplexer Mic In slider to the MIC ANALOG LOOP reference setting (if available; otherwise, it is set to the center of its range), and varies the level of the applied signal to locate the level one step below the level that produces 1% THD+N in the DUT output. This point is considered to be 0 dBFS. See RECORD Level Reference Settings on page 24.

0 dBr A(REC)
0 dBr B(REC)

This amplitude is set as the instrument generator reference, which PC Audio Test refers to as the MIC RECORD Level Reference, or 0 dBr $_{(REC)}$.

Do MIC RECORD Level Reference FIRST!

MIC RECORD Level Reference **must** be determined before any other measurements involving the Mic inputs (MIC RECORD, RECORD/PLAY LOOP with Mic input) can be made.

Rec mixer Mic In Slider position

<MicLineInSlider>

Mic In (Recording) Slider setting

PC Audio Test reads the recording mixer Mic In slider position at MIC RECORD Level Reference. The position is reported as a step number.

See the **Slider Position** sidebar on page 41.

THD+N measurement

See the Distortion (THD+N) sidebar on page 44.

MIC REC THD+N

<MicADTHDA>
<MicADTHDB>

For the MIC RECORD THD+N measurement, PC Audio Test applies a 997 Hz sine wave to the DUT Mic Input at a nominal amplitude. The THD+N stimulus is always a 997 Hz sine wave. Depending on your configuration settings, the stimulus level may be at 0 dBr $_{(REC)}$, –1 dBr $_{(REC)}$, –3 dBr $_{(REC)}$, –6 dBr $_{(REC)}$ or at a level of your choice. AES17 specifies the –1 dB stimulus level; WHQL PC2001 specifies –3 dB. For MIC RECORD, 0 dBr is generally much lower (on the order of 30 dB to 40 dB lower) than the 0 dBr established for Line In.

The DUT ADC output is acquired directly within the PC and analyzed for THD+N using FFT techniques. Since the instrument Analog Analyzer cannot be used for this measurement, the weighting or bandpass filters are not available for THD+N measurements in the MIC RECORD path.

In accordance with accepted practice for PC sound device measurements, PC Audio Test expresses THD+N results relative to the MIC RECORD Level Reference (0 dBr) rather than to the stimulus tone level.

Dynamic Range measurement

See the Dynamic Range sidebar on page 48.

For the MIC RECORD path dynamic range measurement, PC Audio Test applies a 997 Hz sine wave at a very low level to the Mic Input jacks. This tone is typically set 60 dB below the Mic In level.

MIC RECORD Dynamic Range

<MicADDynRangA>
<MicADDynRangB>

The DUT ADC output is acquired directly within the PC and analyzed for dynamic range, referenced to 0 dBFS.

Frequency Response measurement

See the Frequency Response sidebar on page 53.

For the MIC RECORD Frequency Response measurement, PC Audio Test uses a multitone technique. An appropriate multitone signal is applied to the DUT Mic Input at a nominal level. Depending on your configuration settings, the may be at 0 dBr $_{(REC)}$, –1 dBr $_{(REC)}$, –3 dBr $_{(REC)}$, –6 dBr $_{(REC)}$ or at a level of your choice.

MIC RECORD Frequency Response

<MicADResponse>

NOTE: You can specify a custom multitone signal for frequency response testing. Custom multitone signals can be created using the Audio Precision Multitone Creation utility or by downloading files from the Audio Precision Web site at audioprecision.com. See Frequency Response Settings on page 26.

The multitone signal in the DUT ADC output is acquired directly within the PC and is analyzed using FFT techniques, resulting in a graph showing both frequency and phase response.

Passband Ripple measurement

See the Passband Ripple sidebar on page 55.

A second multitone and second FFT analysis are automatically performed during the MIC RECORD Frequency Response measurements. These results are smoothed and subjected to Compute calculations, providing a Passband Ripple measurement of the DUT's ADC. The Passband Ripple results are displayed as a graph on a linear scale.

MIC RECORD Passband Ripple

<MicADRipple>

RECORD/PLAY LOOP Measurement Path

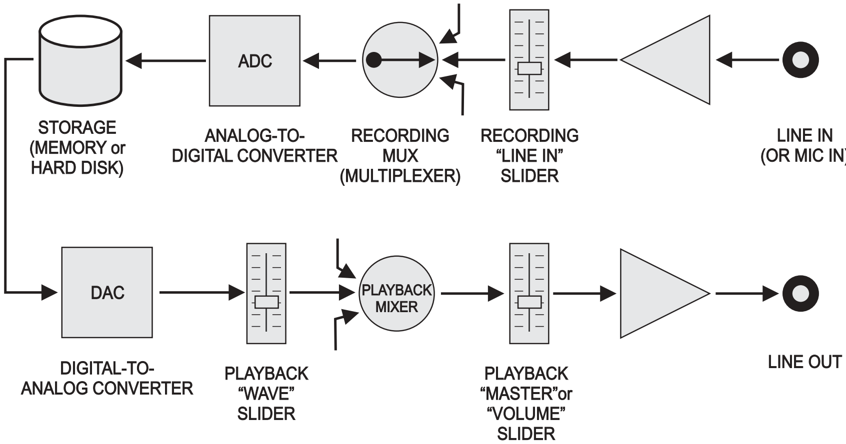


Figure 40. RECORD/PLAY LOOP path block diagram.

Introduction to RECORD/PLAY LOOP (A-D-PC-D-A path)

The RECORD/PLAY LOOP path is a combination of the RECORD and PLAY paths. Some of the key measurements for this path were performed in the RECORD and PLAY paths, such as the PLAY and RECORD Reference Level measurements. Other measurements are established in this path mode.

Stimulus signals for the RECORD/PLAY LOOP path

For both single-tone and multitone RECORD/PLAY LOOP measurements, PC Audio Test controls the instrument analog generator, providing the appropriate analog stimulus signal to the DUT inputs for each measurement.

R/P LOOP THD+N

<ADDATHDA>
<ADDATHDB>

THD+N measurement

See the Distortion (THD+N) sidebar on page 44.

For the RECORD/PLAY LOOP THD+N measurement, PC Audio Test applies a 997 Hz sine wave to the DUT Line Input at a nominal amplitude. The THD+N stimulus is always a 997 Hz sine wave. Depending on your configuration settings, the stimulus level may be at 0 dBr $_{(REC)}$, –1 dBr $_{(REC)}$, –3 dBr $_{(REC)}$, –6 dBr $_{(REC)}$ or at a level of your choice. AES17 specifies the –1 dB stimulus level; WHQL PC2001 specifies –3 dB.

This signal is routed through the DUT ADC and digitally recorded as a temporary wave file. The file is then played and routed through the DUT DAC and to the Line Out jacks. The DUT analog output is analyzed for THD+N.

As an option, you can apply an analyzer weighting or bandpass filter; if a THD+N measurement is filtered, it is typically with a bandpass filter. WHQL, however, specifies a weighting filter.

The filter must be installed and available in your Audio Precision instrument. See **Test Settings** in Chapter 2 for more information on applying filters to the THD+N measurements.

NOTE: In accordance with accepted practice for PC sound device measurements, PC Audio Test expresses <SKIP> results relative to the Level Reference rather than to the stimulus tone level.

Dynamic Range measurement

R/P LOOP Dynamic Range

<ADDADynRngA>
<ADDADynRngB>

See the Dynamic Range sidebar on page 48.

For the RECORD/PLAY LOOP Dynamic Range measurement, PC Audio Test applies a 997 Hz sine wave at a very low level to the Line Input jacks. This tone is typically set to –60 dB relative to the DUT Analog Input Level. The tone is removed by a narrow notch filter in the analyzer before the residue is measured.

This signal is routed through the DUT ADC and digitally recorded as a temporary wave file. The file is then played and routed through the DUT DAC and to the Line Out jacks. The DUT analog output is analyzed for Dynamic Range.

You can also apply an analyzer weighting or bandpass filter to the Dynamic Range measurement; if a Dynamic Range measurement is filtered, it is typically with a weighting filter.

The filter must be installed and available in your Audio Precision instrument. See **Test Settings** in Chapter 2 for more information on applying filters to the Dynamic Range measurements.

Frequency Response measurement

R/P LOOP Frequency Response

<ADDAResponse>

See the Frequency Response sidebar on page 53.

For the RECORD/PLAY LOOP Frequency Response measurement, PC Audio Test uses a multitone technique. An appropriate multitone signal is applied to the DUT Line Input at a nominal level. Depending on your configuration settings, the stimulus level may be at 0 dBr $_{(REC)}$, –1 dBr $_{(REC)}$, –3 dBr $_{(REC)}$, –6 dBr $_{(REC)}$ or at a level of your choice.

NOTE: You can specify a custom multitone file for frequency response testing. Custom multitone files can be created using the Audio Precision Multitone Creation utility or by downloading files from the Audio Precision Web site at audioprecision.com. See Frequency Response Settings on page 26.

R/P LOOP Frequency vs Relative Phase

<ADDAResponse>

The multitone in the DUT analog output signal is analyzed in your Audio Precision instrument using FFT techniques, resulting in a graph showing both frequency and phase response.

DIGITAL LOOP Measurement Path

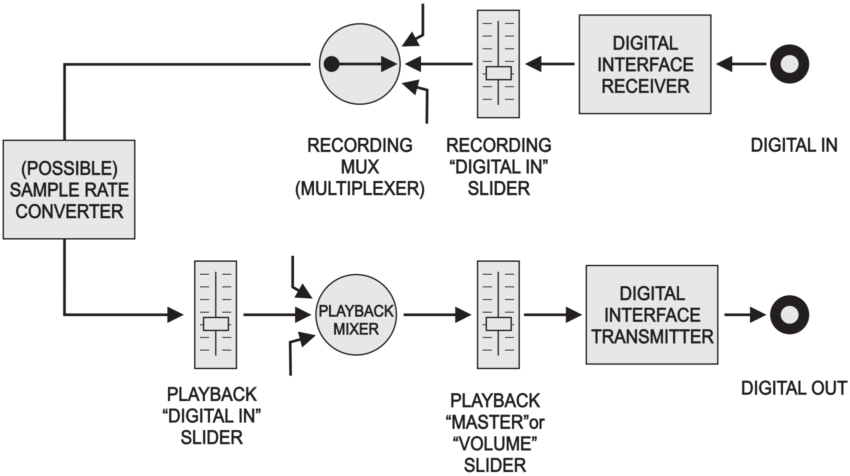


Figure 41. DIGITAL LOOP path block diagram.

Introduction to DIGITAL LOOP Measurement Path (D-D path)

Unlike the other measurement paths, DIGITAL LOOP does not test the audio capabilities of the DUT. Instead, this path evaluates the digital interface characteristics, measuring interface electrical parameters, compliance with AES3 and 60958 (S/PDIF) protocols, and data handling accuracy.

DIGITAL LOOP Sample Rate

<DDOutSR>

The full DIGITAL LOOP measurement path requires that the DUT has both a digital input and digital output. The digital stimulus signal is applied to the digital input, routed through the recording mixer and then through the playback mixer to the digital output.

Not all PC audio devices have digital inputs or outputs, or both. PC Audio Test can perform some partial-loop path measurements for PC audio devices that have only a digital input or a digital output, but not both.

Interface Characterization measurements

DIGITAL LOOP Output Voltage

<DDOutV>

For DUTs that have a digital output, PC Audio Test measures the DUT Digital Output impedance (Z_s) and signal voltage (peak-to-peak). The output sample rate is measured.

For DUTs that have a digital input, PC Audio Test measures the Digital Input impedance.

Protocol Verification

DIGITAL LOOP
Status Bits Summ.

<DDOutStatBit>

For DUTs that have a digital output, the output interface signal metadata protocol is evaluated, providing a Status Bits summary, a verification of correct Error Flag display, and a verification of the output resolution and output sample rate indicator bits, and the state of the Device Type (indicating SRC) and Valid bits.

Chapter 4

Viewing and Reporting Results

PC Audio Test provides test results as XML text. Different sets of results may be saved as separate XML files.

The Results Viewer displays a dynamic HTML document that provides a formatted version of the current XML results data for viewing and reporting. You can create custom HTML files to format the XML data for many different purposes.

The Results Viewer

Choose **View** > **Results** or click the Results Viewer button on the toolbar to open the Results Viewer.

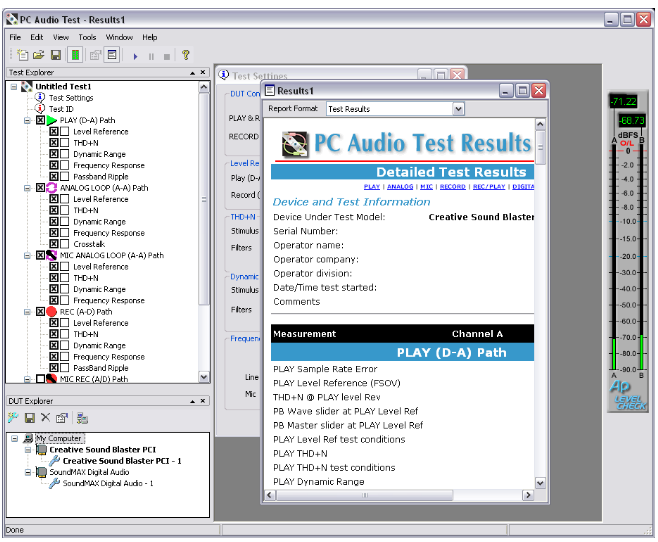


Figure 42. PC Audio Test workspace with the Results Viewer.

The Results Viewer shows the XML results as formatted dynamic HTML. Because this is a dynamic HTML display, the data do not reside in the HTML document but are read “on the fly” from the XML results. If a test is running while the Results Viewer is open, the window is constantly updated with current results as the test progresses.

Saving Results

You can save test results as an XML file and later open the file to print a report. The Results Viewer will always show the current results, whether from a test just run or from a previously saved results file that has been opened.

The XML file always contains all of the results from a particular test. What you see in the dynamic HTML display of the Results Viewer depends on the HTML template file in use.

Like any XML file, the XML results file can be formatted and filtered to many purposes by means of a style sheet. XML-compatible applications including the Office XP versions of Microsoft Excel and Word can open the XML file directly for editing and reformatting.

If you copy the results file, remember to include the style sheet (*.xsl) and the HTML template in use to maintain the same formatting and filtering.

HTML templates

The HTML documents that act as templates for the Results Viewer are located in the Reports folder under the PC Audio Test installation folder. Four HTML templates are provided with PC Audio Test. You can easily add your own custom report template to this collection. The templates include

- **Test Results**
  This is the report used for the default Test Results window display. It is comprehensive, in that it shows the result of every test and measurement performed by PC Audio Test. This template is optimized for on-screen viewing.
- **Comprehensive**
  This template displays the same comprehensive set of results as **Test Results** but is optimized for printed output.
- **Comprehensive without diagrams**
  This template is the same as **Comprehensive**, but includes only one signal path diagram (as compared to seven diagrams in **Comprehensive**.)
- **PC-2001**
  This template produces a WHQL report listing specific items required by PC-2001, optimized for printing.

You can add custom HTML templates for your own needs. Edit one of the templates or design a new HTML document in the text editor or Web tool of your choice, and save it in the Results folder. Result values are entered into report templates as XML data tags. For a complete listing of PC Audio result data tags, see the tables in Appendix B.

The four HTML templates provided all use the cascading style sheet named pc_audio_test_results.css for formatting. If you copy these templates or a new one you have created by editing a template, be sure to copy the style sheet to the new location, too.

To add your custom HTML document to the Results Viewer template list, you must edit the file **reports.xml**. Open the file in a text editor and insert a new line listing the filename and list name of your new file, as shown in Figure 43.

```
1 <?xml version="1.0"?>
2 <reports xmlns="http://www.audioprecision.com/pcaudio/reports">
3   <report href="test_results.html" title="Test Results"/>
4   <report href="comprehensive/index_comprehensive_report.htm" title="Comprehensive Report"/>
5   <report href="comprehensive_nodiagrams/index_comprehensive_report.htm" title="Comprehensive Report, no diagrams"/>
6   <report href="PC2001/pc2001_test_report.htm" title="PC2001 Test Report"/>
7   <report href="My_New_Report.htm" title="My New Report"/>
8 </reports>
```

Figure 43. Edited “reports.xml” showing addition of My New Report at line 7.

Printing Reports

To print a report from within PC Audio Test, first be sure that the test results you wish to report are the current results in PC Audio Test. Then simply load the HTML template of your choice into the results viewer and choose **File > Print.**

You can save a formatted report as a PDF file if you have Adobe Acrobat installed on your computer. Choose **File > Print >PDF Writer** or an equivalent command for your system.

Chapter 5

Remote Testing

Introduction

PC Audio Test can control and test a DUT in another computer over a Windows network connection by using DCOM, a wire protocol for communicating with software components on other computers. DCOM is a standard feature of Microsoft Windows and is included in with Windows operating system installations.

In a production environment this capability can smooth operations and save time by enabling you to operate PC Audio Test from a host (local) computer while performing measurements on a PC audio device in a client (or target) computer.

Requirements

There are several requirements for remote testing with PC Audio Test, which are highlighted here and discussed in detail in following topics.

The Host Computer

- APP-2010 PC Audio Test must be installed on the host (local) computer.
- The Audio Precision control software must be installed on the host computer.
- The Audio Precision instrument must be connected to the host computer via APIB.
- The host computer must be a node on a well-formed Microsoft Windows network.

The Target Computer

- APP-2010 PC Audio Test must be installed on the target computer.
- The target computer must be a node available to the host computer on the Microsoft Windows network.
- Authentication level, controlling computer location, security permissions and user identity must be properly set in the DCOM Config dialog.

NOTE: It is beyond the scope of this manual to discuss in any detail the configuration of a Microsoft Windows network or of DCOM. Online Help is available within the Microsoft Management Console window (which must be opened to access DCOM configuration), and much information is available from Microsoft and others in commercial technical publications and on the Web.

The DUT

- The DUT must be installed in the target computer
- The DUT must have audio and grounding connections to the Audio Precision instrument.

Equipment Location for Remote Testing

There are practical cable-length limitations both to the Audio Precision instrument control cable (the APIB cable) and to the audio and grounding cables connected between the instrument and the DUT. These considerations place a limit on the maximum distance between the local computer and the target computer.

APIB cable length limitations

Audio Precision instruments will operate properly using an APIB interconnection up to 12 m (40') in length. This is the length of two standard Audio Precision APIB cables connected end-to-end.

Audio and Grounding cable length limitations

Audio interconnections are subject to noise and interference pickup and to signal loss through cable reactance. The severity of these effects is effected by circuit impedance, signal level and environmental considerations. To minimize cable losses and noise pickup, we recommend that your audio cables do not exceed the 2 m (6.5') length of the cables included with PC Audio Test.

To be effective, the grounding cable must connect the DUT to the instrument by a very low impedance. For a given gauge, longer cable lengths present higher impedances. To minimize ground-induced hum and noise, we recommend that your ground cable does not exceed the 2 m (6.5') length of the cable included with PC Audio Test.

Software Installation for Remote Testing

APP-2010 (PC Audio Test) and instrument control software must be installed on the host computer. See Chapter 2.

Additionally, you must install APP-2010 software on the target computer. To do this,

- Close all applications on the target computer.
- Insert the APP-2010 PC Audio Test disk into the target computer CD-ROM drive.
- The Windows Autorun features should automatically open the installation menu shown in Figure 12. If this does not occur, click the **Start** button on the Windows taskbar. Then click **Run** and type **D:\Setup** and then **OK**, where “D” is the drive letter of the CD-ROM drive.
- On the installation menu, click **Install APP-2010 Software** to install PC Audio test.

Configuring DCOM

DCOM requires that remote users be identified, have proper permission, etc., to control PC Audio test. You must properly configure DCOM and security permissions on the client (target) computer to use PC Audio Test.

The following steps will guide you in setting up DCOM and the security permissions on the client computer. These steps are described for Microsoft Windows XP. We do not recommend using Windows 2000 or Windows 98 for remote testing.

There may be different combinations of permissions and other settings necessary to properly configure DCOM for PC Audio Test use, depending upon the configuration of your host computer and the design of your network.

Windows XP

The technician performing the test must be an administrator for the client computer. Go to **Control Panel > User Accounts** to view or change this setting.

Run dcomcnfg

Windows XP provides a DCOM configuration dialog within the Component Services area of the Microsoft Management Console utility. You can access this dialog from the Windows Run dialog box.

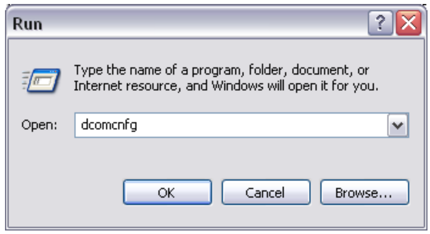


Figure 44. "Run" command line to launch DCOM configuration.

On the target computer taskbar, click **Start** and then **Run**, and enter "dcomcnfg" . Click **OK**. The Component Services window of the Microsoft Management Console will open.

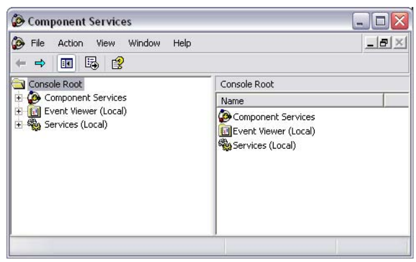


Figure 45. Component Services window.

First view or change the target computer's default settings by navigating to **Component Services > Computers > My Computer** and right-clicking to open the **Properties** dialog. Choose the **Default Properties** tab, select **Enable Distributed COM on this computer** and verify that **Default Authorization Level** is set to **Connect**.

Close the **Properties** dialog to return to the Component Services window. Access the configuration properties of the PC Audio Test SoundServer COM application by expanding the tree and navigating to **Component Services > Computers > My Computer > DCOM Config > Audio Precision PC Audio Test SoundServer,** as shown in Figure 46.

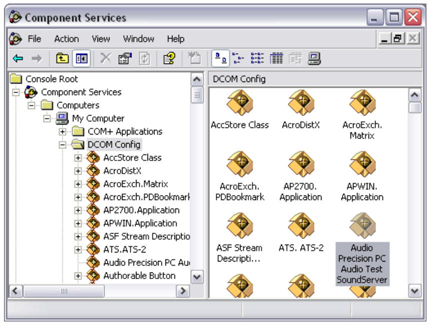


Figure 46. Navigation to PC Audio Test SoundServer COM application.

Right-click on the Audio Precision PC Audio Test SoundServer icon and chose **Properties** from the menu. A tabbed properties dialog box will open.

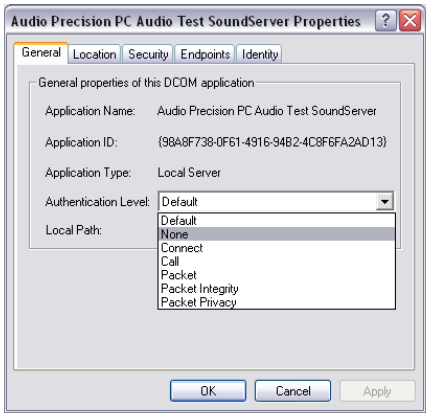


Figure 47. Audio Precision PC Audio Test SoundServer Properties dialog box, General tab.

On the General tab, set Authorization Level to **Connect**.

---

*NOTE: If the computer's default setting is **Connect**, you may select **Default** in this dialog. See page 72 for instructions for viewing or changing the default setting.*

On the Location tab, select **Run application on this computer**, and be sure that the other options are not checked.

On the Security tab, for

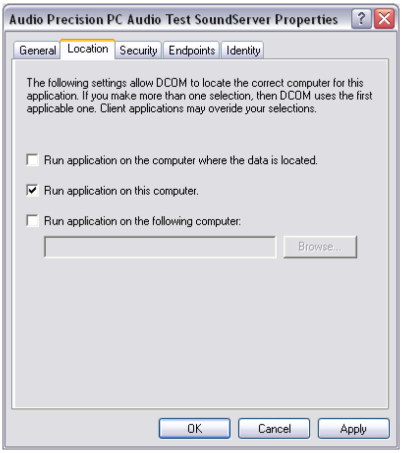


Figure 48. Audio Precision PC Audio Test SoundServer Properties dialog box, Location tab.

- Launch Permissions,
  select **Customize** and click the **Edit** button. If the host computer's name is not available, click **Add** and enter the name. In the Permissions box, click **Allow**.

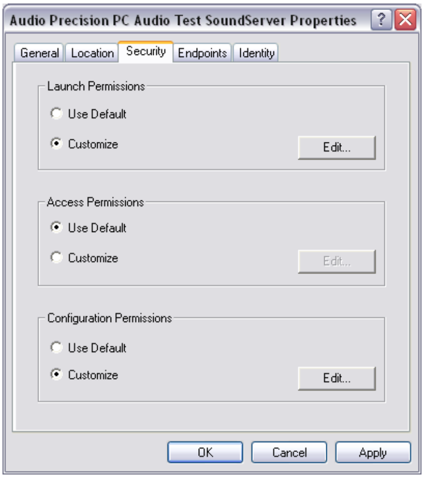


Figure 49. Audio Precision PC Audio Test SoundServer Properties dialog box, Security tab.

- Access Permissions,
  select **Customize** and click the **Edit** button. If the host computer's name is not available, click **Add** and enter the name. In the Permissions box, click **Allow**.

Figure 50. Audio Precision PC Audio Test SoundServer Properties dialog box, Identity

On the Identity tab, select **This user**, and enter the technician's user name and password in the fields.

Connecting the Hardware

See Chapter 2 for detailed information about hardware connections. For remote testing of a PC audio device in a target computer, you must connect the audio and ground connections from your Audio Precision instrument to the target PC audio device. The instrument APIB control connection remains connected to the host computer. See Figure 51.

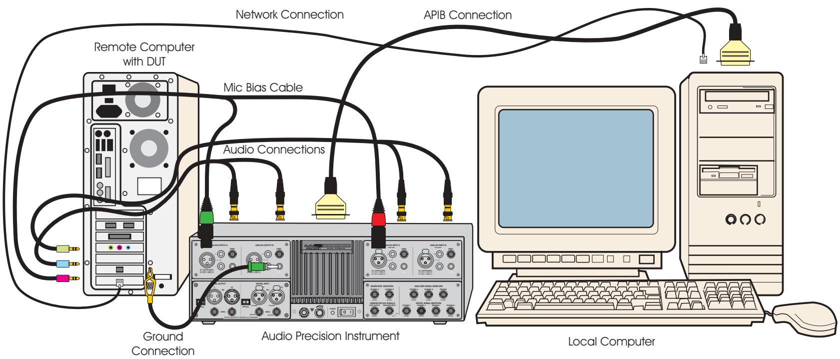
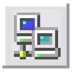


Figure 51. Remote test configuration.

Remote Testing with DCOM

Once you have installed PC Audio Test on the target computer, configured DCOM and made the audio and grounding connections, remote testing is just as easy as local testing.



In the DUT Explorer toolbar, click the Network button, labeled Connect to a Remote Computer. Browse to the target machine and click **OK**.

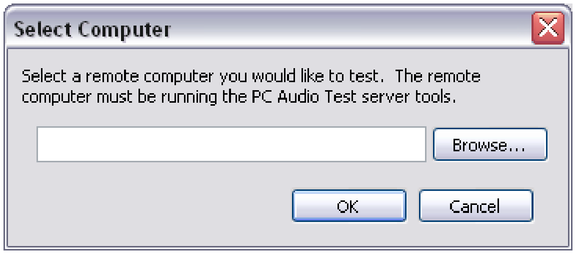


Figure 52. Remote computer browser dialog.

This will reveal the DUTs installed in the target computer, and they will appear in the DUT explorer in the target computer's branch. Select the DUT for testing and proceed with your test as described in Chapter 3.

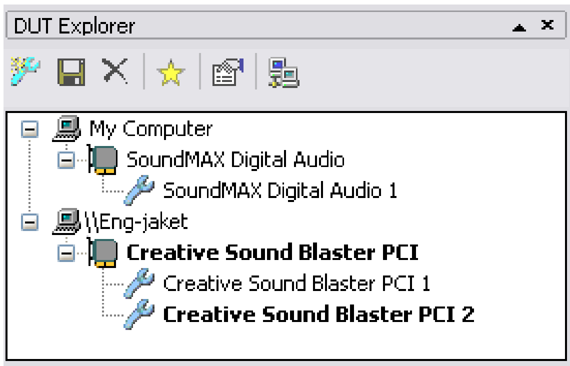


Figure 53. Choosing a DUT on a remote computer.

Appendix A
Troubleshooting

Compatibility with Windows APIs

Most applications communicating with the Microsoft Windows operating system to control multimedia audio streams do so using the APIs provided with the operating system. An API is an *application programmer's interface*, and the two APIs used in PC audio applications are the Windows WaveIO API and the Windows Mixer API. Volume Control, Sound Recorder and Windows Media Player (all included in a Windows installation) are examples of applications that control audio using these APIs, as is Audio Precision's PC Audio Test.

The dedicated mixer and control panels included with most sound cards and other PC audio devices are almost always compatible with the Windows WaveIO API. However, many PC audio devices are *not* fully compatible with the Windows Mixer API. Demand for new features often results in designs with controls and capabilities that are not included in the Windows Mixer API, and custom software drivers must be included with the audio device to accommodate these non-standard controls.

PC Audio Test cannot access non-standard controls, and when a PC audio devices has non-standard controls in a test path, these controls must be manually set or disabled.

The Windows Mixer API

The Windows Mixer API makes audio sources (SRC) and destinations (DST) available, with controls that modify the connecting mixer lines.

These relationships are displayed graphically in the standard Windows Mixer panel (SndVol32.exe). The Playback mixer shows the mixer lines (and their controls) connected to the Speakers destination; the Record mixer shows the mixer lines and controls connected to the Wave destination.

A utility called MixApp.exe is included with PC Audio Test that can be used to view the entire set of mixer parameters (sources, destinations, controls) defined by the PC audio device under test.

Special Run Modes for PC Audio Test

In attempting to perform tests on devices that do not use the Windows Mixer API or use it in non-standard ways, PC Audio Test may encounter muting, routing, effect or volume controls that are not accessible, and some or all of the tests may fail or report results that do not represent the best performance of the device under test.

PC Audio Test has two special run modes that can be used when problems arise in testing non-standard PC audio devices. These modes are accessed by launching the PC Audio Test using a command line with an argument “switch” to set the mode. You can launch PC Audio Test with a command line by using the Windows “Run” dialog box as described below; or, you can make a shortcut that includes the switch argument in the target string.

These two run modes modify the way that PC Audio Test controls the DUT driver mixer controls. The tests become less automated, giving you the opportunity to make settings optimized to the DUT design. However, PC Audio Test is not able to optimize levels effectively in these special run modes, and it becomes the operator’s responsibility to choose routing, muting and level settings that produce correct, optimum test results.

AutoOff

The first special run mode is called AutoOff. In this mode, only the mixer line currently being tested is controlled by the PC Audio Test; all other mixer controls are unaffected. The other controls may be manually set to mute, to maximum, or to any other setting.

The quality of the test results results depend on your choices in setting the other controls. Some controls will have no effect on the test results; others may add noise, increase distortion, reduce dynamic range and so on.

Typical Run dialog or shortcut targe command string for AutoOff mode:

- `“C:\Program Files\Audio Precision\PC Audio\pcaudio.exe” /AutoOff`

Notice that the switch argument is outside of the final quotes. This command is case-sensitive.

AllMax

The second run mode is called AllMax. In this mode, all mutes are set to OFF (channel ON) and all volumes are set to maximum.

This mode can be used to circumvent mixer line conflicts or dependencies. Some multi-channel PC sound devices, for example, may have additional volume controls such as front and rear for surround configurations. If you are using the front output for your measurement, you may have to adjust both the main volume control and the additional front volume control to produce a signal at the output. In AllMax mode, all mixer lines are on and you will be able to measure signal at the output.

Once you have measured signal and determined the mixer controls that affect your measurement path, you can optimize you test by manually muting unused controls and optimizing those in the path.

Typical Run dialog or shortcut targe command string for AllMax mode:

- `“C:\Program Files\Audio Precision\PC Audio\pcaudio.exe” /AllMax`

Notice that the switch argument is outside of the final quotes. This command is case-sensitive.

Manual Override

Some PC audio devices do not use the Windows Mixer API at all, but use instead use their own proprietary drivers.

In such cases, it is necessary to use the PC Audio Test manual override function for each test group being tested. Each test path has an associated manual override checkbox on the DUT Configuration Properties panel. Check the box and then adjust the associated mixer control setting.

For each test path, you can manually set the proper test signal reference level while monitoring control software displays. Once this level has been established, the tests for that group can be run and results will be generated based on this reference value.

Manual override allows you to test PCaudio devices that do not support the Windows Mixer API. You must carefully optimize your settings to ensure the best performance of the DUT. See detailed instructions for operating PC Audio Test in manual override beginning on page .

Test Failures

Connection and Configuration

Many test failures are cause by improper connection or configuration. Be sure your cables are connected properly. Check that the DUT configuration panel is set to enable the proper instrument inputs and outputs, and that the DUT driver software has the appropriate control selected for each measurement path. See **the DUT Configuration panel**, page 16.

Ground Check

Improper grounding can cause poor results and even test failures by introducing high levels of interfering noise into the system. Be sure to connect a heavy ground connection between the instrument and the computer fitted with the DUT. Click Ground Check on the DUT configuration panel to evaluate your ground connection. See **Ground Check**, page 19.

Level Reference Failures

If connection and configuration are properly set up and grounding is optimized, most Level Reference failures will be due to atypical design of the associated DUT function. Most DUTs fall within a standard design range, but some will add non-standard switches or volume controls, design controls with very coarse or non-linear volume steps, or add unpredictable compression or peak limiting. The automatic level characterization algorithms of PC Audio Test are quite sophisticated but cannot anticipate non-standard DUT architectures.

In such cases, you must manually set levels in the affected signal path, disabling the PC Audio Test automatic level setting algorithms and instead using the DUT driver controls and monitoring the instrument control software displays. Specific instruction for manual level setting in the PLAY, ANALOG LOOP and RECORD measurement paths follow.

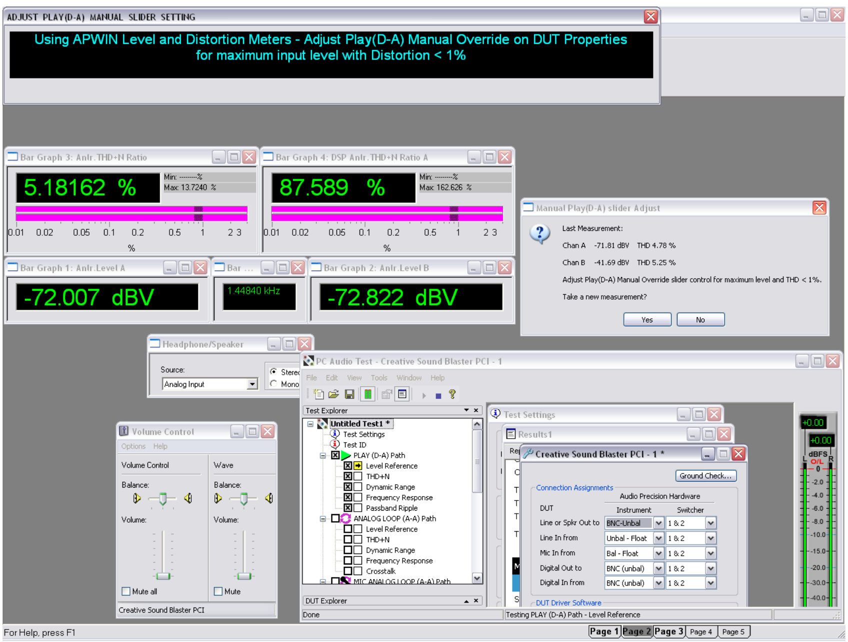


Figure 54. Screen display for a typical Manual Override adjustment setting session.

Figure 54 shows a typical user interface for manual override setting. Notice that the Windows Volume Control Mixer is visible, and that PC Audio Test is running in a small window so that the control software displays can be viewed.

To enable manual setting for a control, check the manual override box for that control on the DUT Configuration panel. In most cases, you will want to open the DUT mixer window as well. The default Windows mixer is called Volume Control and is available at Start > Programs > Accessories > Entertainment > Volume Control. Proprietary mixers will be available from other locations.

Once the Manual Override checkbox is checked, you can set the level of that control from a mixer panel or by entering a number between 1 and the maximum step number (which varies greatly with DUT design) in the Manual Override control field. Be sure there to check for non-standard mixer controls (such as Front or Back in a surround-capable DUT) that may affect PLAY levels. Set such controls that are in the signal path to maximum, and set those controlling other signals that may be mixed with the PLAY signal to minimum.

Manual PLAY level control setting

See **PLAY Measurement Path** on page 37 for reference.

PC Audio Test's PLAY Reference Level algorithm attempts to find the correct playback operating level for the DUT by searching for the maximum PLAY level that produces less than 1% distortion (THD+N) at the DUT Line or Speaker output.

To locate the optimal level manually, first open the DUT Playback mixer and set the Master Volume and the PLAY volume (usually the Wave control) to their maximum. In PC Audio Test, click **Run**. The following dialog box will open.

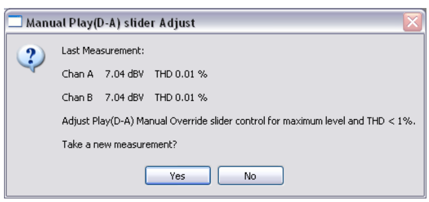


Figure 55. The PLAY manual adjustment dialog.

This dialog tells you the measured level and distortion at the DUT output. By adjusting the Wave control volume (either from the DUT Configuration panel or from the DUT's playback mixer), find the maximum level possible that produces less than 1% distortion. Monitor the control software readings, and click the **Yes** button in the dialog box to make a new measurement. As you raise the level, there will usually be a threshold at which the distortion increases greatly; set the level just below this point. Then continue with your test.

NOTE: You may notice high distortion readings at very low control settings while making these settings. The ranging of the instrument input circuits will amplify system noise under conditions of very low signal, and the noise reading will be expressed as a distortion reading.

Manual ANALOG LOOP level control setting

See **ANALOG LOOP Measurement Path** on page 42 for reference.

PC Audio Test's ANALOG LOOP Reference Level algorithm attempts to find the correct analog in-to-out operating level for the DUT by searching for the maximum generator setting and Line In (playback) slider control level that produces less than 1% distortion (THD+N) at the Line or Speaker output.

To locate the optimal level manually, first open the DUT Playback mixer and set the Master Volume and the analog input volume (usually the Line In control) to their maximum. In PC Audio Test, click **Run**. The following dialog box will open.

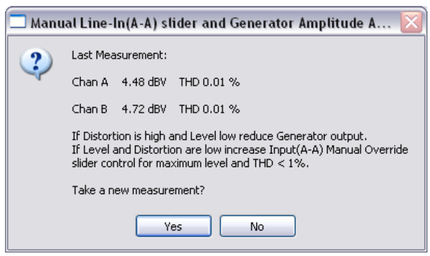


Figure 56. The ANALOG LOOP manual adjustment dialog.

This dialog tells you the measured level and distortion at the DUT output. By adjusting the Line In control volume (either from the DUT Configuration panel or from the DUT's playback mixer), find the maximum level possible that produces less than 1% distortion. Monitor the control software readings, and click the **Yes** button in the dialog box to make a new measurement. As you raise the level, there will usually be a threshold at which the distortion increases greatly; set the level just below this point.

If the lowest setting of Line In still produces more than 1% distortion and level is high, set the Line In control at lowest active setting. Adjust the instrument Analog Generator level downward (a Bar Graph control is available in the control software display to set and view the generator level) until you find the find the maximum level possible that produces less than 1% distortion.

NOTE: You may notice high distortion readings at very low control settings while making these settings. The ranging of the instrument input circuits will amplify system noise under conditions of very low signal, and the noise reading will be expressed as a distortion reading.

Then continue with your test.

Manual RECORD level control setting

See **RECORD** Measurement Path on page 53 for reference.

PC Audio Test's RECORD Reference Level algorithm attempts to find the correct analog input recording level for the DUT by searching for the generator setting and Line In (recording) slider control level that produces a digital level just below 0 dBFS, at less than 1% distortion.

To locate the optimal level manually, first open the DUT Recording mixer and select the analog input control (usually the Line In control) and set it to maximum. In PC Audio Test, click **Run**. The following dialog box will open.

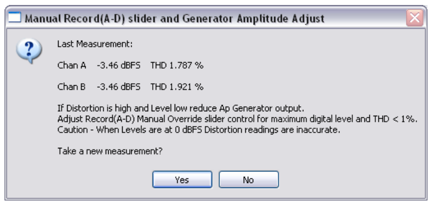
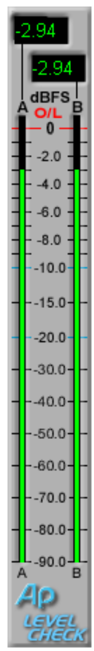


Figure 57. The ANALOG LOOP manual adjustment dialog.



This dialog tells you the distortion and digital level measured within the DUT by proprietary techniques in PC Audio Test. By adjusting the Line In (recording) control volume (either from the DUT Configuration panel or from the DUT's recording mixer), find the maximum level possible that produces less than 1% distortion. Monitor the PC Audio Test digital meter, and click the **Yes** button in the dialog box to make a new measurement. As you raise the level, there will usually be a threshold at which the distortion increases greatly; set the level just below this point. This level is usually very close to 0 dBFS.

If the lowest setting of Line In still produces more than 1% distortion and level is high, set the Line In control at lowest active setting. Adjust the instrument Analog Generator level downward (a Bar Graph control is available in the control software display to set and view the generator level) until you find the find the maximum level possible that produces less than 1% distortion.]

Then continue with your test.

NOTE: Many DUTs employ audio compression or limiting circuits between the Line In jack and the DUT ADC circuits. In may cases, these circuits may make it impossible to approach or equal 0 dBFS, or they may induce high distortion in the signal several dB below 0 dBFS.

Test Messages

In the course of operating PC Audio Test you may see dialog boxes reporting test status, caution and error messages. These may be generated by PC Audio Test, by the instrument control software or by the computer operating system. The messages created by PC Audio Test follow with explanations.

General

> *An internal error has occured.*
> *Value is over list item max.*

The above message is issued by the control software. In PC Audio Test use, it means that the THD+N or Dynamic Range filter specified in your Test Settings is not installed in the Audio Precision instrument.

> ***ERROR - Test Failed***
> *No Data or Sweep Timed Out*
> *Signal may have been interrupted.*

The above message can apply to any test. Configuration is correct, but measurement failed. This is usually a connection problem, such as cable not connected or connected to the wrong DUT or instrument port. For frequency response, crosstalk or passband ripple tests (which use multitone measurements), a high level of DUT "glitching" can cause this failure.

> ***ERROR - Test Failed***
> *Max/Min Compute failed.*
> *Signal may have been interrupted.*

The above message applies to frequency and phase sweeps. The data acquired for computation may be corrupted. Try re-running the test.

> **_ERROR_**
>
> *Chan A and / or Chan B signal below –20 dBV*
> *Check Connections and DUT Properties Configuration.*

Messages like the one above can appear at various places within the measurement procedure. The specified level (here shown as –20 dBV) may be different depending on the test requirement. This message usually means there is no signal, which points to a connection problem, a DUT or instrument configuration problem or an extra DUT software driver mixer control that is not enabled.

> **_ERROR_**
>
> *Frequency not within 1% of 997 Hz*
> *Check Test Settings for correct Sample Rate.*

Messages like the one above can appear at various places within the measurement procedure. The specified frequency (here shown as 997 Hz) may be different depending on the test requirement. This message usually means there is a disagreement between the sample rate set on the DUT Configuration panel and the sample rate of the requested waveform file; or, it may mean no signal, which usually means a connection problem, a DUT or instrument configuration problem or an extra DUT software driver mixer control that is not enabled.

> **_ERROR_**
>
> *Reference waveform (.agm) file Not found for current sample rate.*

The above message reflects a Test Settings setup error (or a missing file). It means that no level reference file exists for the sample rate you specified on the Test Settings panel. This message appears with the first test after the erroneous Test Settings entry.

> **_ERROR_**
>
> *Passband Ripple test waveform (.agm) file Not found for current sample rate.*

The above message reflects a Test Settings setup error (or a missing file). It means that no passband ripple file exists for the sample rate you specified on the Test Settings panel. This message appears with the first passband ripple test after the erroneous Test Settings entry.

> ***ERROR***
>
> *Ap Generator Regulation Error:*
> *Err.Number*
> *Err.Description*

The above message indicates a regulation error within the control software when PC Audio Test is adjusting analog level reference. This is usually due to unstable or varying signal level or frequency; or possibly noise or interference in the DUT.

> ***Caution***
>
> *Levels are out of balance by ##0.0 dB*
> *Check DUT Pan / Balance.*

The above message may appear at any point in a test. It indicates a Channel A to Channel B level imbalance, due to Pan or Balance control settings in the DUT software driver mixer.

D-A LevelRef

> ***Manual Play(D-A) slider Adjust***
>
> *Last Measurement:*
> *Chan A ##0.00 dBV THD ##0.00 %*
> *Chan B ##0.00 dBV THD ##0.00 %*
> *Adjust Play(D-A) Manual Override slider control for maximum level and THD < 1%.*
> *Take a new measurement?*

The above message appears during the PLAY manual override level setting procedure. This dialog reports the current level and distortion, and with the control software displays is an aid to DUT control adjustment. Click YES to submit a new setting or NO to accept the current setting.

> ***ADJUSTMENT FAILED***
>
> *Low Output level and THD+N > 1%*
>
> *Master and WAV slider at maximum. Probable No-Signal condition.*
>
> *Check Connections and DUT Properties Configuration.*

This message usually means there is no signal, which usually points to a connection problem, a DUT or instrument configuration problem or an extra DUT software driver mixer control that is not enabled.

> ***ADJUSTMENT FAILED***
>
> *Low Output level. WAV slider at maximum.*
>
> *Master slider is manually set - Check setting.*

The message above usually means there is no signal, which points to a connection problem, a DUT or instrument configuration problem or an extra DUT software driver control that is not enabled. This message appears only when the Master slider control has been set to manual override, so check the Master setting.

> ***ADJUSTMENT FAILED***
>
> *WAV slider is at minimum and THD+N > 1%.*

This is unusual, but it can happen. The DUT D-A path is overloading when a full-level (0 dBFS) digital signal is played.

> ***ADJUSTMENT FAILED***
>
> *20 adjustment loops done. Unity Gain slider setting not found.*
>
> *On the DUT Properties Configuration Record (D-A) check Manual Override.*
>
> *Set slider for maximum level and THD < 1%.*

After 20 tries to find the correct PLAY level setting, PC Audio Test has given up, and you must go to manual override for this path. Failure to find the PLAY level setting can be due to varying signal levels, signal interruption, non-standard DUT driver control, or extreme nonlinearity in the driver control law.

> ***ADJUSTMENT FAILED***
>
> *20 single-step adjustment loops done. Unity Gain slider setting not found.*
>
> *On the DUT Properties Configuration Record (D-A) check Manual Override*
>
> *Set slider for maximum level and THD < 1%.*

This message is the same as the previous message, but is the result of a different (single-step) minimization routine.

> ***CAUTION***
>
> *Levels are Out of Balance more than one slider step: #0.0 dB.*

This message notes a balance offset of more than one slider step. At this point in the test the pan or balance controls have been checked, so the problem is likely due to analog circuit imbalance. In DUTs with very fine slider resolution, this caution may not be important.

A-A LevelRef

> ***DUT Configuration***
>
> *Line-In control selected is a Microphone control type.*
>
> *Use anyway?*

Some DUTs use the same physical connections and mixer controls for Line In and for Mic In. When this setting is selected, PC Audio Test checks to be sure it is not a mistake.

Manual Line-In (A-A) slider and Generator Amplitude Adjust

Last Measurement:

Chan A ##0.00 dBV THD ##0.00 %

Chan B ##0.00 dBV THD ##0.00 %

If Distortion is high and Level low reduce Generator output.

If Level and Distortion are low increase Input (A-A) Manual Override

Set slider control for maximum level and THD < 1%.

Take a new measurement?

The above message appears during the ANALOG LOOP manual override level setting procedure. This dialog reports the current level and distortion, and with the control software displays is an aid to DUT control adjustment. Click YES to submit a new setting or NO to accept the current setting.

ERROR

Line In or Line Out Channel Connections are Reversed.

Check DUT Connections and Configuration

Channel A and Channel B connections (for either the DUT inputs or outputs) have been switched one for the other.

ADJUSTMENT FAILED

20 adjustment loops done. Unity Gain slider setting not found.

On the DUT Properties Configuration Input(A-A) check Manual Override.

Set slider for maximum level and THD < 1%.

After 20 tries to find the correct ANALOG LOOP level setting, PC Audio Test has given up, and you must go to manual override for this path. Failure to find the ANALOG LOOP level setting can be due to varying signal levels, signal interruption, non-standard DUT driver control, or extreme nonlinearity in the driver control law.

Mic A-A LvlRef

> ***DUT Configuration***
>
> *Mic In control selected is Not a Microphone control type.*
> *Use anyway?*

Some DUTs use the same physical connections and mixer controls for Line In and for Mic In. When this setting is selected, PC Audio Test checks to be sure it is not a mistake.

> ***ERROR***
>
> *Chan A output signal below –30 dBV*
> *Check Connections and DUT Properties Configuration.*

This message usually means there is no signal, which usually points to a connection problem, a DUT or instrument configuration problem or an extra DUT software driver mixer control that is not enabled.

> ***ERROR***
>
> *Chan B output signal below -30 dBV*
> *Check Mono mode or DUT Pan/Balance set to center.*

In Mic In, DUTs assign a mono mic signal to both Channels A and B. If Channel B is quite low, check that the DUT driver software pan or balance controls are centered.

> ***ADJUSTMENT FAILED***
>
> *20 adjustment loops done. Mic Input slider setting not found.*
>
> *On the DUT Properties Configuration Microphone(A-A) check Manual Override.*
>
> *Set slider for maximum level and THD < 1%.*

After 20 tries to find the correct MIC ANALOG LOOP level setting, PC Audio Test has given up, and you must go to manual override for this path. Failure to find the MIC ANALOG LOOP level setting can be due to varying signal levels, signal interruption, non-standard DUT driver control, or extreme nonlinearity in the driver control law.

> ***ERROR***
>
> *Ap Generator Regulation Error:*
> *Err.Number*
> *Err.Description*

The above message indicates a regulation error within the control software when PC Audio Test is adjusting analog level reference. This is usually due to unstable or varying signal level or frequency; or possibly noise or interference in the DUT.

A-D LevelRef

> ***Manual Record(A-D) slider and Generator Amplitude Adjust***
>
> *Last Measurement:*
>
> *Chan A ##0.00 dBFS THD ##0.000 %*
>
> *Chan B ##0.00 dBFS THD ##0.000 %*
>
> *If Distortion is high and Level low reduce Generator output.*
>
> *Adjust Record(A-D) Manual Override slider control for maximum digital level and THD < 1%.*
>
> *Caution - When Levels are at 0 dBFS Distortion readings are inaccurate.*
>
> *Take a new measurement?*

The above message appears during the RECORD manual override level setting procedure. This dialog reports the current level and distortion, and with the control software and PC Audio Test digital meter displays is an aid to DUT control adjustment. Click YES to submit a new setting or NO to accept the current setting.

> ***ERROR***
>
> *Record Input Channel Connections are Reversed*
>
> *Check DUT Connections and Configuration*

Channel A and Channel B connections (for either the DUT inputs or outputs) have been switched one for the other.

ERROR

Both channels have signal with only Chan A Input.
DUT feeds both channels with Monaural input.

Either by design or in the DUT driver mixer configuration, Channel A is connected to both Channel A and Channel B within the DUT. In other words, the DUT "monos" the input. This is often the case with the motherboard PC audio device implementations in laptop and notebook computers.

ADJUSTMENT FAILED

20 adjustment loops done. Record slider setting not found.

On the DUT Properties Configuration Record (A-D) check Manual Override.

Set slider for maximum digital level and THD < 1%.

After 20 tries to find the correct RECORD level setting, PC Audio Test has given up, and you must go to manual override for this path. Failure to find the RECORD level setting can be due to varying signal levels, signal interruption, non-standard DUT driver control, or extreme nonlinearity in the driver control law.

Mic A-D LevelRef

> ***Manual Record(A-D) slider and Generator Amplitude Adjust***
>
> *Last Measurement:*
>
> *Chan A ##0.00 dBFS THD ##0.000 %*
>
> *Chan B ##0.00 dBFS THD ##0.000 %*
>
> *If Distortion is high and Level low reduce Generator output.*
>
> *Adjust Record(A-D) Manual Override slider control for maximum digital level and THD < 1%.*
>
> *Caution - When Levels are at 0 dBFS Distortion readings are inaccurate.*
>
> *Take a new measurement?*

The above message appears during the MIC RECORD manual override level setting procedure. This dialog reports the current level and distortion, and with the control software displays is an aid to DUT control adjustment. Click YES to submit a new setting or NO to accept the current setting.

> ***ERROR***
>
> *Record Input Channel Connections are Reversed*
>
> *Check DUT Connections and Configuration*

Channel A and Channel B connections (for either the DUT inputs or outputs) have been switched one for the other.

> ***ERROR***
>
> *Both channels have signal with only Chan A Input.*
>
> *DUT feeds both channels with Monaural input.*

Either by design or in the DUT driver mixer configuration, Channel A is connected to both Channel A and Channel B within the DUT. In other words, the DUT “monos” the input. This is often the case with the motherboard PC audio device implementations in laptop and notebook computers.

ADJUSTMENT FAILED

20 adjustment loops done. Record slider setting not found.

On the DUT Properties Configuration Record(A-D) check Manual Override.

Set slider for maximum digital level and THD < 1%.

After 20 tries to find the correct MIC RECORD level setting, PC Audio Test has given up, and you must go to manual override for this path. Failure to find the MIC RECORD level setting can be due to varying signal levels, signal interruption, non-standard DUT driver control, or extreme nonlinearity in the driver control law.

Appendix B

Results Listings

Introduction

This Appendix contains comprehensive lists of all test results XML data tags by measurement path. Collection names and other information that may be helpful in designing tests and HTML report templates are included.

- Column One is the **Description** of the measurement.
- Column Two is the **Collection Name**. The collection name is the string variable you must use in report templates to return a particular result value.
- Column Three is the **Data Type** for that collection name. Possible data types are
  - **Str**.
  - **Dbl**.
  - **Lng**.
  - **Dbl array**.
- Column Four is the value **Formatting** applied. This formatting is independent of page formatting you may apply in your report template.
- Column Five is the **Unit** for the result value. String variables with value formatting applied will include a unit reference in the result value string. Such units are shown here in quotation marks. Units shown without quotation marks are not included in the result value string.
- Column Six is the **Reference** for the result, when applicable.

See Chapter 4 for information about HTML report templates.

PLAY (D-A) Path Results

Description	Collection Name	Data Type	Formatting	Unit
PLAY Sample Rate Error	DASRateErr	Str	##0.000	"%"
PLAY Level Reference Ch A (FSOV) (0 $dBr_{(PLAY)}$ A)	DAFSLvlA	Str	##0.0000	"V"
PLAY Level Reference Ch B (FSOV) (0 $dBr_{(PLAY)}$ B)	DAFSLvlB	Str	##0.0000	"V"
PLAY THD+N @ Level Ref Ch A	DAFSTHDA	Str	##0.000	"%"
PLAY THD+N @ Level Ref Ch B	DAFSTHDB	Str	##0.000	"%"
PB mixer Wave slider position @ PLAY Level Ref	WAVOutSlider	Lng	no	steps
PB mixer Master slider position @ PLAY Level Ref	MasterSlider	Lng	no	steps
PLAY LevelRef test conditions	DALvlRefTstCond	Str	no	
PLAY THD+N Ch A	DATHDA	Str	##0.000	"dBr"
PLAY THD+N Ch B	DATHDB	Str	##0.000	"dBr"
PLAY THD+N test conditions	DATHDTstCond	Str	no	
PLAY Dynamic Range Ch A	DADynRngA	Str	##0.000	"dBr"
PLAY Dynamic Range Ch B	DADynRngB	Str	##0.000	"dBr"
PLAY Idle NoiseCh A	DAIdleNoiseA	Str	##0.000	"dBr"
PLAY Idle NoiseCh B	DAIdleNoiseB	Str	##0.000	"dBr"
PLAY Dynamic Range test conditions	DADynRngTstCond	Str	no	
PLAY Max Pos Phase Error	DAPhaseMax	Str	##0.000	"deg"
PLAY Max Neg Phase Error	DAPhaseMin	Str	##0.000	"deg"
PLAY Frequency Response Frequencies	DAResponse	Dbl array	no	Hz
PLAY Frequency Response Ch A	DAResponse	Dbl array	no	dBV
PLAY Frequency Response Ch B	DAResponse	Dbl array	no	dBV
PLAY Frequency vs Relative Phase	DAResponse	Dbl array	no	deg
PLAY Frequency Response test conditions	DARespTstCond	Str	no	
PLAY Frequency Response Limit	DARespLimit	Str	no	
PLAY Passband Ripple Frequencies	DARipple	Dbl array	no	Hz
PLAY Passband Ripple Ch A	DARipple	Dbl array	no	dBV
PLAY Passband Ripple Ch B	DARipple	Dbl array	no	dBV
PLAY Passband Ripple test conditions	DARippleTstCond	Str	no	
PLAY Passband Ripple Limit	DARippleLimit	Str	no	

ANALOG LOOP (A-A) Path Results

Description	Collection Name	Data Type	Formatting	Unit
ANLG LOOP Level Reference Ch A	AAFSLvlA	Str	##0.000000	"V"
ANLG LOOP Level Reference Ch B	AAFSLvlB	Str	##0.000000	"V"
ANLG LOOP THD+N @ Level Ref Ch A	AAFSTHDA	Str	##0.000	"%"
ANLG LOOP THD+N @ Level Ref Ch B	AAFSTHDB	Str	##0.000	"%"
ANLG LOOP Line In Level Ch A	AAInLvlA	Str	##0.000000	"V"
ANLG LOOP Line In Level Ch B	AAInLvlB	Str	##0.000000	"V"
ANLG LOOP Unity Gain Error Ch A	AAUnityGainErrA	Str	##0.00	"dB"
ANLG LOOP Unity Gain Error Ch B	AAUnityGainErrB	Str	##0.00	"dB"
PB mixer Line In (monitor) slider position @ ANLG LOOP Level Ref	LineMonOutSlider	Lng	no	steps
ANLG LOOP Level Reference test conditions	AALvlRefTstCond	Str	no	
ANLG LOOP THD+N Ch A	AATHDA	Str	##0.000	"dBr"
ANLG LOOP THD+N Ch B	AATHDB	Str	##0.000	"dBr"
ANLG LOOP THD+N test conditions	AATHDTstCond	Str	no	
ANLG LOOP Dynamic Range Ch A	AADynRngA	Str	##0.000	"dBr"
ANLG LOOP Dynamic Range Ch B	AADynRngB	Str	##0.000	"dBr"
ANLG LOOP Dynamic Range test conditions	AADynRngTstCond	Str	no	
ANLG LOOP Signal-to-Noise Ratio Ch A	AASNRA	Str	##0.000	"dBr"
ANLG LOOP Signal-to-Noise Ratio Ch B	AASNRB	Str	##0.000	"dBr"
ANLG LOOP Signal-to-Noise Ratio test conditions	AASNRTstCond	Str	no	
ANLG LOOP Crosstalk A to B	AAXtlkA-B	Str	##0.000	"dB"
ANLG LOOP Crosstalk B to A	AAXtlkB-A	Str	##0.000	"dB"
ANLG LOOP Crosstalk test conditions	AAXtlkTstCond	Str	no	
ANLG LOOP Max Pos Phase Error	AAPhaseMax	Str	##0.000	"deg"
ANLG LOOP Max Neg Phase Error	AAPhaseMin	Str	##0.000	"deg"
ANLG LOOP Frequency Response Frequencies	AAResponse	Dbl array	no	Hz
ANLG LOOP Frequency Response Ch A	AAResponse	Dbl array	no	dBV
ANLG LOOP Frequency Response Ch B	AAResponse	Dbl array	no	dBV
ANLG LOOP Frequency vs Relative Phase	AAResponse	Dbl array	no	deg
ANLG LOOP Frequency Response test conditions	AARespTstCond	Str	no	
ANLG LOOP Frequency Response Limit	AARespLimit	Str	no	

MIC ANALOG LOOP (A-A) Path Results

Description	Collection Name	Data Type	Formatting	Unit
MIC LOOP Level Reference Ch A	AAMicFSLvlA	Str	##0.000000	"V"
MIC LOOP Level Reference Ch B	AAMicFSLvlB	Str	##0.000000	"V"
MIC LOOP THD+N @ Level Ref Ch A	AAMicFSTHDA	Str	##0.000	"%"
MIC LOOP THD+N @ Level Ref Ch B	AAMicFSTHDB	Str	##0.000	"%"
MIC LOOP Mic In Level @ Level Ref (mono)	AAMicInLvl	Str	#,##0.000	"mV"
PB mixer Mic In (monitor) slider position @ MIC LOOP Level Ref	MicInSlider	Lng	no	steps
MIC LOOP Level Reference test conditions	AAMicLvlRefTstCond	Str	no	
Mic In Boost Gain	AABoostGain	Str	#0.0	"dB"
Mic In Gain Maximum	AAMaxMicGain	Str	#0.0	"dB"
Mic In Bias Voltage	MicInSupplyV	Str	#0.00	"Vdc"
Mic In Bias Current	MicInSupplyI	Str	#00.0	"mA"
MIC LOOP THD+N Ch A	AAMicTHDA	Str	##0.000	"dBr"
MIC LOOP THD+N Ch B	AAMicTHDB	Str	##0.000	"dBr"
MIC LOOP THD+N test conditions	AAMicTHDTstCond	Str	no	
MIC LOOP Dynamic Range Ch A	AAMicDynRngA	Str	##0.000	"dBr"
MIC LOOP Dynamic Range Ch B	AAMicDynRngB	Str	##0.000	"dBr"
MIC LOOP Dynamic Range test conditions	AAMicDynRngTstCond	Str	no	
MIC LOOP Signal-to-Noise Ratio Ch A	AAMicSNRA	Str	##0.000	"dBr"
MIC LOOP Signal-to-Noise Ratio Ch B	AAMicSNRB	Str	##0.000	"dBr"
MIC LOOP Signal-to-Noise Ratio test conditions	AAMicSNRTstCond	Str	no	
MIC LOOP Max Pos Phase Error	AAMicPhaseMax	Str	##0.000	"deg"
MIC LOOP Max Neg Phase Error	AAMicPhaseMin	Str	##0.000	"deg"
MIC LOOP Frequency Response Frequencies	AAMicResponse	Dbl array	no	Hz
MIC LOOP Frequency Response Ch A	AAMicResponse	Dbl array	no	dBV
MIC LOOP Frequency Response Ch B	AAMicResponse	Dbl array	no	dBV
MIC LOOP Frequency vs Relative Phase	AAMicResponse	Dbl array	no	deg
MIC LOOP Frequency Response test conditions	AAMicRespTstCond	Str	no	
MIC LOOP Frequency Response Limit	AAMicRespLimit	Str	no	

RECORD (A-D) Path Results

Description	Collection Name	Data Type	Formatting	Unit
REC Level Reference Ch A	ADFSLvlA	Str	##0.000	"dBFS"
REC Level Reference Ch B	ADFSLvlB	Str	##0.000	"dBFS"
REC THD+N @ REC Level Ref Ch A	ADFSTHDA	Str	##0.000	"dBFS"
REC THD+N @ REC Level Ref Ch B	ADFSTHDB	Str	##0.000	"dBFS"
* REC Line In Level @ REC Level Ref Ch A (FSIV) (0 $dBr_{(REC)}$.)	ADInLvlA	Str	##0.000000	"V"
* REC Line In Level @ REC Level Ref Ch B (FSIV) (0 $dBr_{(REC)}$.)	ADInLvlB	Str	##0.000000	"V"
* Rec mixer Line In slider position @ REC Level Ref	LineInSlider	Lng	no	steps
** REC Mic In Level @ REC Level Ref	ADMicInLvl	Str	#,##0.000	"mV"
** Rec mixer Mic In slider position @ REC Level Ref	MicLineInSlider	Lng	no	steps
REC Level Reference test conditions	ADLvlRefTstCond	Str	no	
REC THD+N Ch A	ADTHDA	Str	##0.000	"dBFS"
REC THD+N Ch B	ADTHDB	Str	##0.000	"dBFS"
REC THD+N test level Ch A	ADTHDLvlA	Str	##0.000	"dBFS"
REC THD+N test level Ch B	ADTHDLvlB	Str	##0.000	"dBFS"
REC THD+N test conditions	ADTHDTstCond	Str	no	
REC Dynamic Range Ch A	ADDynRngA	Str	##0.000	"dBFS"
REC Dynamic Range Ch B	ADDynRngB	Str	##0.000	"dBFS"
REC Dynamic Range test level Ch A	ADDynRngLvlA	Str	##0.000	"dBFS"
REC Dynamic Range test level Ch B	ADDynRngLvlB	Str	##0.000	"dBFS"
REC Dynamic Range test conditions	ADDynRngTstCond	Str	no	
REC Max Pos Phase Error	ADPhaseMax	Str	##0.000	"deg"
REC Max Neg Phase Error	ADPhaseMin	Str	##0.000	"deg"
REC Frequency Response Frequencies	ADResponse	Dbl array	no	Hz
REC Frequency Response Ch A	ADResponse	Dbl array	no	dBV
REC Frequency Response Ch B	ADResponse	Dbl array	no	dBV
REC Frequency vs Relative Phase	ADResponse	Dbl array	no	deg
REC Frequency Response test conditions	ADRespTstCond	Str	no	
REC Frequency Response Limit	ADRespLimit	Str	no	
REC Passband Ripple Frequencies	ADRipple	Dbl array	no	Hz
REC Passband RippleCh A	ADRipple	Dbl array	no	dBV
REC Passband RippleCh B	ADRipple	Dbl array	no	dBV
REC Passband Ripple test conditions	ADRippleTstCond	Str	no	
REC Passband Ripple Limit	ADRippleLimit	Str	no	
REC (MIC) Frequency Response Limit	ADMicRespLimit	Str	no	
*These results are not used when the RECORD path measurements are performed using the mic input for PCs that have no Line Input, typical of many notebook computers. Instead, the results marked with ** are used.				

MIC RECORD (A-D) Path Results

Description	Collection Name	Data Type	Formatting	Unit
MIC REC Level Reference Ch A	MicADFSLvlA	Str	##0.000	"dBFS"
MIC REC Level Reference Ch B	MicADFSLvlB	Str	##0.000	"dBFS"
MIC REC THD+N @ MIC REC Level Ref Ch A	MicADFSTHDA	Str	##0.000	"dBFS"
MIC REC THD+N @ MIC REC Level Ref Ch B	MicADFSTHDB	Str	##0.000	"dBFS"
MIC In DUT Input Level	ADMicInLvl	Str	##0.000000	"mV"
Full Scale Input Volt (Mic In) (FSIV) (0 dBr$_{(REC)}$.)	AD-FSIV-Mic	Str	##0.000000	"V"
Gen ampl. @ RefLvl w/ Mic In	MicLvlGenOutRecLine	Lng	no	V(N)
Rec mixer Mic In slider position @ MIC REC Level Ref	MicLineInSlider	Lng	no	steps
MIC REC (A-D) Level Reference test conditions	MicADLvlRefTstCond	Str	no	
Mic Boost Gain	MicBoostGain	Str	##0.0	“dB”
Maximum Mic In Gain	MicMaxGain	Str	##0.0	“dB”
Mic Supply Voltage	MicInSupplyV	Str	##0.00	“V”
Mic Supply Current	MicInSupplyI	Str	##00.0	“mA”
MIC REC THD+N Ch A	MicADTHDA	Str	##0.000	"dBFS"
MIC REC THD+N Ch B	MicADTHDB	Str	##0.000	"dBFS"
MIC REC THD+N test level Ch A	MicADTHDLvlA	Str	##0.000	"dBFS"
MIC REC THD+N test level Ch B	MicADTHDLvlB	Str	##0.000	"dBFS"
MIC REC THD+N test conditions	MicADTHDTstCond	Str	no	
MIC REC Dynamic Range Ch A	MicADDynRngA	Str	##0.000	"dBFS"
MIC REC Dynamic Range Ch B	MicADDynRngB	Str	##0.000	"dBFS"
MIC REC Dynamic Range test level Ch A	MicADDynRngLvlA	Str	##0.000	"dBFS"
MIC REC Dynamic Range test level Ch B	MicADDynRngLvlB	Str	##0.000	"dBFS"
MIC REC Dynamic Range test conditions	MicADDynRngTstCond	Str	no	
MIC REC Max Pos Phase Error	MicADPhaseMax	Str	##0.000	"deg"
MIC REC Max Neg Phase Error	MicADPhaseMin	Str	##0.000	"deg"
MIC REC Frequency Response Frequencies	MicADResponse	Dbl array	no	Hz
MIC REC Frequency Response Ch A	MicADResponse	Dbl array	no	dBV
MIC REC Frequency Response Ch B	MicADResponse	Dbl array	no	dBV
MIC REC Frequency vs Relative Phase	MicADResponse	Dbl array	no	deg
MIC REC Frequency Response test conditions	MicADRespTstCond	Str	no	
MIC REC Frequency Response Limit	MicADRespLimit	Str	no	
MIC REC Passband Ripple Frequencies	MicADRipple	Dbl array	no	Hz
MIC REC Passband RippleCh A	MicADRipple	Dbl array	no	dBV
MIC REC Passband RippleCh B	MicADRipple	Dbl array	no	dBV
MIC REC Passband Ripple Limit	MicADRippleLimit	Str	no	
MIC REC Passband Ripple test conditions	MicADRippleTstCond	Str	no	

RECORD/PLAY LOOP (A-D-PC-D-A) Path Results

Description	Collection Name	Data Type	Formatting	Unit
R/P LOOP THD+N Ch A	ADDATHDA	Str	##0.000	"dBr"
R/P LOOP THD+N Ch B	ADDATHDB	Str	##0.000	"dBr"
R/P LOOP THD+N test conditions	ADDATHDTstCond	Str	no	
R/P LOOP Dynamic Range Ch A	ADDADynRngA	Str	##0.000	"dBr"
R/P LOOP Dynamic Range Ch B	ADDADynRngB	Str	##0.000	"dBr"
R/P LOOP Dynamic Range test conditions	ADDADynRngTstCond	Str	no	
R/P LOOP Max Pos Phase Error	ADDAPhaseMax	Str	##0.000	"deg"
R/P LOOP Max Neg Phase Error	ADDAPhaseMin	Str	##0.000	"deg"
R/P LOOP Frequency Response Frequencies	ADDAResponse	Dbl array	no	Hz
R/P LOOP Frequency Response Ch A	ADDAResponse	Dbl array	no	dBV
R/P LOOP Frequency Response Ch B	ADDAResponse	Dbl array	no	dBV
R/P LOOP Frequency vs Relative Phase	ADDAResponse	Dbl array	no	deg
R/P LOOP Frequency Response test conditions	ADDARespTstCond	Str	no	
R/P LOOP Frequency Response Limit	ADDARespLimit	Str	no	

DIGITAL LOOP (D-D) Path Results

Description	Collection Name	Data Type	Formatting	Unit
D-D LOOP Digital Interface Output Voltage	DDOutV	Str	##0.000	"Vp-p"
D-D LOOP Digital Interface Sample Rate	DDOutSR	Str	##0,000.0	"Hz"
D-D LOOP Digital Interface Output Impedance (Zs)	DDOutZ	Str	##0.	"ohms"
D-D LOOP Interface Output Intrinsic Jitter	DDOutJitter	Str	#0.000	"nsec"
D-D LOOP Digital Interface Output Flag Errors	DDOutFlags	Str	no	
D-D LOOP Digital Interface Output bit resolution	DDOutRes	Str	#0.	"bits"
D-D LOOP Digital Interface Output Stat bits summary	DDOutStatBit	Str	no	
D-D LOOP Sample Rate Converter in use	DDSRC	Str	no	
D-D LOOP Output Bit Validity	DDBitOutValid	Str	no	
D-D LOOP Valid Output Bit Resolution	DDBitOutValidRes	Str	#0.	"bits"
D-D LOOP Valid Output Bit Sample rate	DDBitOutValidSR	Str	##0,000.0	"Hz"
D-D LOOP Interface Input Impedance (Zt)	DDInZ	Str	##0.	"ohms"

Appendix C

Connector Designations

Balanced and unbalanced connections

- **Unbalanced**
  For these purposes *unbalanced* refers to inputs, outputs and interconnections that use only two conductors. One conductor carries the signal "high" and the other conductor carries the signal "low." The low conductor is almost always grounded at one or both ends of the interconnection, and is often the cable shield connection as well.

- **Balanced**
  Balanced refers to inputs, outputs and interconnections that use three conductors, where one conductor carries the signal "high," a second conductor carries the signal "low" and a third conductor is at the system ground. The ground conductor can be grounded at one or both ends of the interconnection and is also the cable shield connection. In a balanced connection, neither side of the audio signal is at ground potential.

Male and female, plug and jack

Most connectors can be divided into *male* and *female* designations, the male having one or more probes and the female corresponding receptacles. A *plug* is usually considered to be a male connector, and a *jack* is a female connector. Circuit outputs are often (but not always) provided on male connectors, and circuit inputs are often available as female connectors.

3.5 mm plugs and jacks

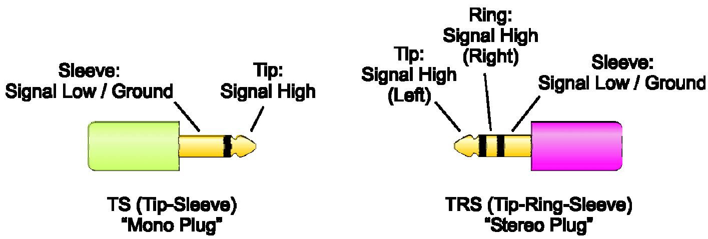


Figure 58. 3.5 mm TS and TRS connectors.

3.5 mm (⅛")connectors are sometimes called mini or mini-phone plugs or jacks. Due to their compact size, these are commonly used as input and output connectors on PC sound cards and on notebook computer sound devices.

The tip-sleeve (TS) version has two conductors and is used for single-channel (or *mono*) unbalanced connections. The tip is connected to the signal high and the sleeve is connected to the signal low (ground). Many PC sound device microphone (Mic) inputs are monaural and use this connector.

The tip-ring-sleeve (TRS) version has three conductors and is ordinarily used as a dual-channel (*stereo*) unbalanced connection. In this configuration, the tip is usually connected to the left channel signal high, the ring is connected to the right channel signal high, and the sleeve is a common signal low at ground potential.

With three conductors, a 3.5 mm TRS connector can also be used as a single-channel (mono) balanced connection, but this is unusual.

¼" phone plugs and jacks

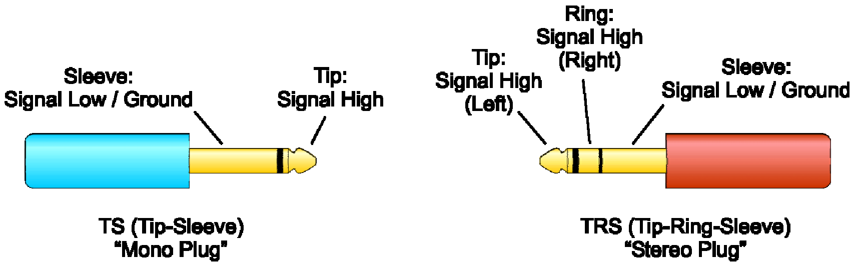


Figure 59. ¼" phone TS and TRS connectors.

¼" phone connectors, like 3.5 mm plugs and jacks, come in tip-sleeve (TS) and tip-ring-sleeve (TRS) versions.

The tip-sleeve (TS) version has two conductors and is used for single-channel (mono) unbalanced connections. The tip is connected to the signal high and the sleeve is connected to the signal low (ground).

The tip-ring-sleeve (TRS) version has three conductors and is ordinarily used as a dual-channel (stereo) unbalanced connection. In this configuration, the tip is usually connected to the left channel signal high, the ring is connected to the right channel signal high, and the sleeve is a common signal low at ground potential.

With three conductors, a ¼" phone TRS connector can also be used as a single-channel or mono balanced connection. This configuration is found on some professional and semi-pro PC sound cards.

RCA or “phono” plugs and jacks

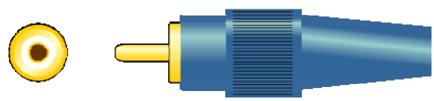


Figure 60. RCA “phono” connectors.

RCA plugs and jacks, also called “phono” plugs and jacks, have two conductors and are used for single-channel unbalanced connections. RCA connectors are found on some PC audio cards as digital inputs and outputs and sometimes as analog connections. RCA connectors are widely used in home stereo and video equipment.

XLR Connectors

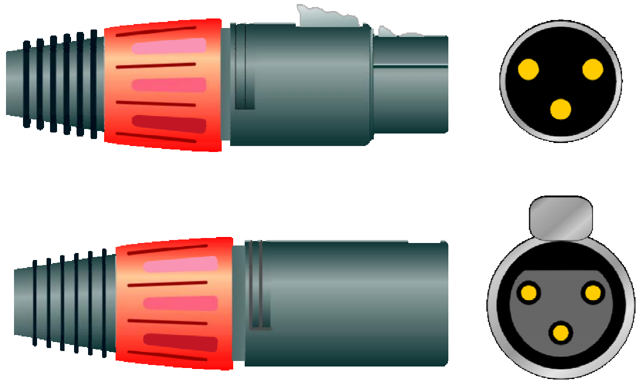


Figure 61. XLR connectors.

In professional and semi-pro audio, many of the audio connections are made using XLR connectors. The XLR designation comes from the Cannon brand XLR-series connectors, and although XLR has become the common name, compatible connectors are made by a number of other manufacturers using different designations.

Some professional and semi-pro PC sound devices offer XLR-3 inputs and outputs (the “3” designates the number of conductors). With three conductors, XLR connectors are usually used as single-channel balanced connectors. AES3 specifies XLR-3 type connectors for professional digital audio interconnection.

BNC connectors

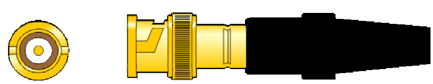


Figure 62. BNC connectors.

BNC connectors have two conductors and are used for single-channel unbalanced connections. BNC connectors are found on test and measurement equipment and in professional television and video applications. BNCs are the standard connector for AES3id digital audio interconnection.

Optical connectors

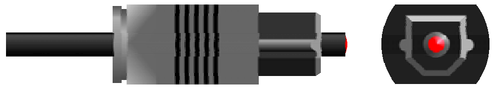


Figure 63. Toslink optical connectors.

Some PC sound devices provide digital output or digital input and output as an optical signal, typically at one or two Toslink connector jacks.

Fan-out connections

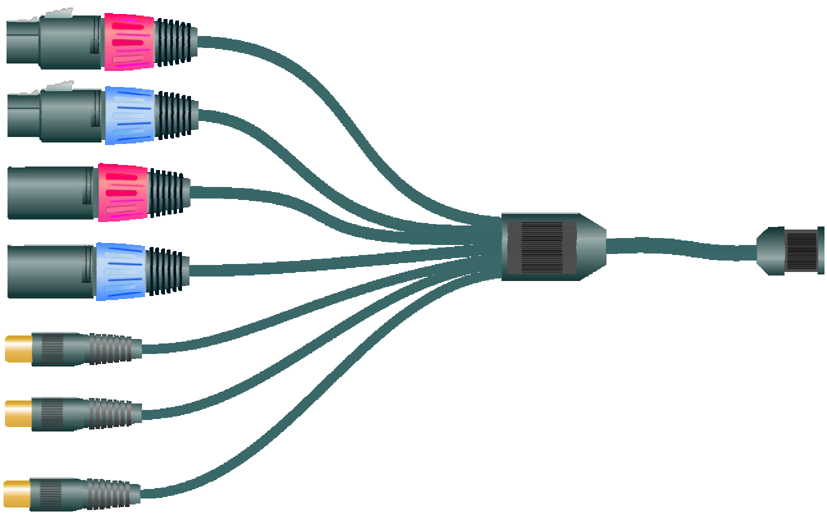


Figure 64. A typical fan-out connector.

For PC sound devices that are specified with many (multitrack) or large (XLR) connectors, a multipin connector with a fan-out cable may be provided.

Digital Connections

Most PC sound devices currently manufactured do not include digital input or output capabilities. More and more are adding digital output only, and a few professional and semi-pro products have both digital output and input.

These digital signals may be carried electrically in the S/PDIF format on unbalanced 3.5 mm jacks or RCA jacks, or may be carried optically on Toslink connectors.

Grounding

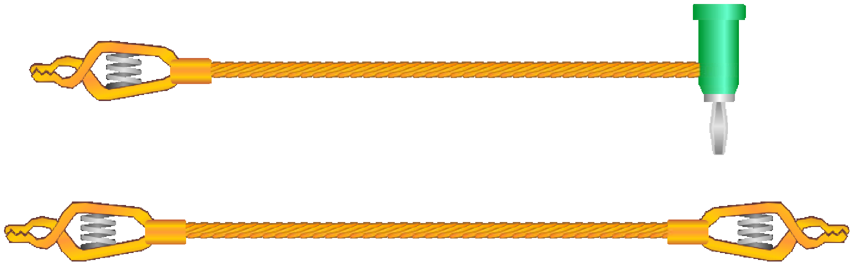


Figure 65. Heavy-gauge grounding cables.

Proper grounding is essential in interconnecting any audio system. For PC audio testing, we recommend that in addition to the ground connections that are carried in the signal cables you add a low-resistance dedicated ground connection.

To be effective, this connection should be a stranded copper wire of large gauge, as short as is reasonable for your interconnection requirements. Each end of this ground wire should be soldered to a large, low-resistance alligator-type clip.

Instrument Analog Connections

Audio Precision instruments have both balanced and unbalanced analog analyzer input and analog generator output connections. Generally, you should use the instrument balanced connectors with balanced DUT connectors, and the instrument unbalanced connectors with unbalanced DUT connectors.

Instrument Digital Connections

Audio Precision instruments have both balanced and unbalanced digital analyzer input and digital generator output connections. The balanced connectors are optimized for the professional AES3 digital format, and the unbalanced connectors are optimized for the consumer S/PDIF digital format.

Using a Switcher

When testing multi-channel PC audio devices or multiple individual devices in the same PC, you may find it convenient to programmatically switch the connections between the instrument and the DUTs.

You can also use a switcher to automatically select Mic In or Line In connections in some configurations.

Audio Precision manufactures input and output switchers that can route many inputs and outputs to and from the instrument generator and analyzer, under the control of PC Audio Test.

Appendix D

Glossary

A-A—PCAQM/PC2001 abbreviation for Analog-Analog measurement path. Commonly referred to in PC Audio Test as the ANALOG LOOP measurement path.

A weighting, A weighting filter—see weighting filter.

ADC—see analog-to-digital converter.

A-D-PC—PCAQM/PC2001 abbreviation for Analog-Digital-Personal Computer measurement path. Commonly referred to in PC Audio Test as the RECORD measurement path.

A-D-PC-D-A—PCAQM/PC2001 abbreviation for Analog-Digital-Personal Computer-Digital-Analog measurement path. Commonly referred to in PC Audio Test as the RECORD/PLAY LOOP measurement path.

AES—the Audio Engineering Society, with headquarters in New York City.

AES3 interface—a digital interface standard for professional audio equipment interconnection, defined in the AES3 standard. Formerly known as the *AES/EBU interface*. The digital signal carried in the AES3 interface is partially compatible with the digital signal carried on the S/PDIF interface.

AES17-1998—A standard providing methods for specifying and verifying the performance of digital audio equipment.

analog audio, analog signal—a representation of an audio signal as a continuously variable quantity. An analog audio signal is usually an electrical voltage varying in analogy to the sound waves it represents.

analog-to-digital converter—a device for converting an analog input signal into a series of digital values representing the instantaneous amplitude of the signal at regular sampling intervals. Abbreviated ADC. See digital recording or processing.

analog-to-digital—abbreviated A-to-D, A/D, A-D and so on. See digital recording or processing and analog-to-digital converter.

AP2700—the Audio Precision control software for the 2700 series of audio test and measurement instruments.

APWIN—the Audio Precision control software for the System One, System Two and System Two Cascade lines of audio test and measurement instruments.

ATS—the Audio Precision control software for ATS-2 audio test and measurement instruments.

balanced—a term referring to an audio transmission line in which the signal is applied differentially between two conductors, each of which has equal impedances to a common reference or ground.
A balanced line is usually constructed with three conductors: an internal twisted pair of wires, one carrying signal "+" or HIGH, the other carrying signal "–" or LOW. These are surrounded by a third conductor in the form of a braided or foil shield, which is connected to the common or ground terminal at one or both ends of the cable.
Used with properly engineered equipment, balanced lines are superior in performance to unbalanced connections, yielding better rejection of common-mode interference caused by electrostatic and electromagnetic fields. Additionally, since the audio in a balanced circuit is isolated from the ground conductor, ground-current-induced noise is much more easily dealt with. Also called a *symmetrical line*. See ground, unbalanced.

bandpass filter—a filter that passes a specific frequency band (called the *passband*) essentially without attenuation while attenuating frequencies both below and above the specified band.

bit depth—see word length.

bits of resolution—the number of bits of the binary word by which signals are represented in a digital recording or transmission system. Each bit adds approximately 6 dB to the theoretical dynamic range available. Thus, a 16-bit digital system is capable of approximately 96 dB dynamic range, etc.

bus—in electricity and electronics, a conductor common to three or more circuits. In computers, the data bus is a set of conductors that carry common data between three or more subunits of the computer.

clipping—the action of a system in flattening and squaring off signal peaks when driven with a signal whose peak amplitude is beyond its linear signal-handling capability.

control software—for Audio Precision products, one of several software programs that control Audio Precision audio test and measurement instruments. APWIN, ATS and AP2700 are examples of Audio Precision control software.

crest factor—the ratio of a signal's peak amplitude to its rms amplitude.

crosstalk—unwanted signal coupling from one channel of a multi-channel transmission or recording system to another.

DAC—see digital-to-analog converter.

dB—abbreviation for decibel, a ratio unit for expressing signal amplitudes. If the amplitudes are expressed in voltage, dB = 20 log10 (V1/V2). If the amplitudes are expressed in power, dB = 10 log10 (P1/P2). Two important points to remember:

- The dB, mimicking our hearing, is not a linear unit but a measurement on a logarithmic scale.
- Decibels are relative units of measure, having no meaning in an absolute sense. A dB must always be referenced to something to have meaning. You can speak of a "4 dB change" or a "60 dB signal-to-noise ratio" because these are both relative statements, but describe a signal level as 39 dB means nothing. All absolute measurements expressed as decibels must have an indication of reference, such as dBu, dBV, dBr and so on. See dBu, dBV, dBr.

dBFS—decibels referenced to digital full scale (FS), where 0 dBFS is the rms value of a sine wave whose positive peak just reaches positive full scale. For everyday use, 0 dBFS can be considered to be the maximum digital amplitude available within a system. However, it should be noted that because 0 dBFS has been defined for a sine wave, waveforms with lower crest factors can exceed 0 dBFS by as much as 3.01 dB before incurring digital clipping. See crest factor and digital clipping.

dBm—decibels relative to a reference value of 1 milliwatt. dBm is a power unit and requires knowledge of power levels (voltage and current, or voltage and impedance, or current and impedance) rather than merely voltage. This term has historically been associated with a measurement of audio levels in professional use, but it is rarely correctly applied and should not be used except in certain very specific circumstances. As a unit of power, the voltage value of a dBm will vary with the circuit impedance.
Use the term *dBu* instead. See dBu.

dBr—decibels relative to an arbitrary reference value, **r**. The reference value must be stated for this to be a meaningful unit. The dBr can be a handy shortcut during tests, allowing you, for example, to measure a specific voltage and note it as your reference, 0 dBr; and then to express further measurements in dBr relative to this level.

dBu—decibels relative to a signal level of 0.7746 V rms. dBu now is the common term for analog audio amplitude in professional audio interfaces and circuits. 0 dBu (0.7746 V rms) equals 0 dBm, but *only* in a 600 ohm load impedance. Unless you are clearly interested in measuring power in a circuit of known impedance, use dBu, not dBm. See dBm.

dBV— decibels relative to a signal level of 1 volt rms. dBV now is the common term for analog audio levels in consumer audio interfaces and circuits. 0 dBV equals +2.218 dBu.

D-D—Abbreviation for Digital-Digital measurement path. Commonly referred to in PC Audio Test as the DIGITAL LOOP measurement path.

digital overflow—see digital clipping.

digital recording or processing—a technique in which the original signal is periodically sampled and the amplitude value at each sampling instant is converted into a number represented by a binary word.

digital-to-analog— Abbreviated D-to-A, D/A, D-A and so on. See digital recording or processing and digital-to-analog converter.

digital-to-analog converter—a device that converts a stream of digital numbers, each representing the amplitude of a signal at a particular sampling time, into a corresponding analog signal. Abbreviated DAC.

DR—PCAQM abbreviation for Dynamic Range measurement.

DSP—digital signal processing.

DUT—device under test.

dynamic range—the difference, usually expressed in dB, between the highest and lowest amplitude portions of a signal, or between the highest amplitude signal that a device can linearly handle and the noise level of the device.

FFT—fast Fourier transform, a technique to compute the amplitude versus frequency and phase versus frequency information from a set of amplitude versus time samples of a signal.

FR—PCQAM1 abbreviation for Frequency Response measurement.

FSIV—PC2001 abbreviation for Full Scale Input Voltage.

FSOV—PC2001 abbreviation for Full Scale Output Voltage.

ground loop—an inadvertent signal path formed when interconnecting the chassis of two or more pieces of equipment, each possessing a safety ground. Ground loops can cause hum-related interference.

instrument—in Audio Precision terms, the hardware component of an Audio Precision test and measurement system, controlled by its control software.

System One, System Two, System Two Cascade, ATS-2 and the 2700 series are examples of Audio Precision instruments. System Two and System Two Cascade are compatible with APP-2010 PC Audio Test.

ISO—International Organization for Standards, the largest of the many international groups for technical and industrial cooperation. The ISO is based in Geneva, Switzerland.

limits testing—testing in which measurements are compared to acceptable values so that a pass/fail decision may be made.

line level—a relatively high amplitude range suitable for transmission of audio signals. Line level is typically in the 0 dBu to +8 dBu range.

measurement path—in PC audio device testing, the combination of software routing and processing and hardware signal path that comprise a distinct mode of operation for the device. PC Audio Test recognizes seven measurement paths: Play, Analog-to-Analog Loop, Mic Analog-to-Analog Loop, Record, Mic Record, Record/Play Loop and Digital Loop.

multitone—testing techniques with stimulus signals consisting of more than one sine wave. Most multitone techniques use 15 or more sine waves distributed across the audio spectrum.

one-third octave—a bandwidth of 1/3 octave, or a frequency ratio of 1.2599:1. Three successive frequency changes by this ratio result in a total frequency change of 2:1 (one octave). Moderately narrow bandpass filters are often set at a bandwidth of 1/3 octave; frequency response measurement techniques that use spot frequencies (such as real-time spectrum analysis or multitone tests) often use frequencies centered at 1/3 octave distances.

passband—the frequency band of a filter in which signals are essentially unattenuated; also the flat response range of a digital converter between the device corner frequencies.

passband ripple—amplitude variations across the passband of a device. This term usually refers to the small-amplitude ripple seen in ADC and DAC response curves.

PCAQM—Personal Computer Audio Quality Measurements.

PC-D-A—PCAQM/PC2001 abbreviation for Personal Computer-Analog-Digital measurement path. Commonly referred to in PC Audio Test as the PLAY measurement path.

pulse code modulation—a form of data transmission in which amplitude samples of an analog signal are represented by digital numbers. Abbreviated PCM. Almost all digital audio schemes use PCM.

resolution—the smallest change in a measured parameter to which a measurement instrument can respond. The resolution of a PCM digital audio system corresponds to its digital word length; digital systems, for example, can be described as having "16 bits of resolution."

rms—see root mean square.

root mean square—the preferred form of ac signal detection that measures amplitude in terms of its equivalent power content, regardless of signal waveshape. Abbreviated rms.

sample frequency, sample rate—the frequency at which the signal is sampled in a digital system. The sample rate must exceed twice the highest analog frequency to be converted. Commonly used sample rates are 48 kHz, 44.1 kHz, and 32 kHz.

signal-to-noise ratio—the difference in level between a reference output signal (typically at the normal or maximum operating level of the device) and the device output with no signal applied. Signal-to-noise ratio is normally stated in dB. The device input conditions for the noise measurement must be specified, such as "input short circuited" or with a specific value of resistance connected at the device input instead of a signal.

S/PDIF—Sony / Philips Digital Interface; a digital interface for consumer audio equipment. Sometimes also referred to as the EIAJ interface. The S/PDIF is similar to the professional AES3 interface, but is normally an unbalanced coaxial signal of lower amplitude. Most of the status byte definitions are different between S/PDIF and AES3.

stimulus—a known signal applied to an audio device under test, chosen to stimulate device behavior useful for the test being performed.

THD+N—total harmonic distortion plus noise. Measured by attenuating the fundamental signal with a narrow-band notch filter, then measuring the remaining signal which consists of harmonics of various order, wide-band noise, and possibly interfering signals. This is the common harmonic distortion method implemented in most analyzers.

third octave—see **one-third octave**.

unbalanced—an audio connection in which the desired signal is present as a voltage with respect to ground or common, rather than as a differential signal across a pair of balanced conductors.

weighting filter—a filter with varying attenuation as a function of frequency so as to produce a measurement where the various spectral components affect the measurement in a specified fashion. Most commonly-used weighting filters are attempts to correspond to the varying response of the human hearing system in order to produce measurements (usually of noise) which correlate well with human observations.

WHQL—Windows Hardware Quality Labs. Microsoft's program to ensure hardware compatibility by recommending standards and implementing compatibility testing and verification. On the Web at www.microsoft.com/hwdq/hwtest/default.asp

WHQL PC2001—The common name referring to the Intel/Microsoft document PC 2001 System Design Guide. Chapter 11 discusses audio requirements. See Appendix E.

XML—Extensible Markup Language (XML) is a simple, very flexible text format derived from SGML (ISO 8879). Originally designed to meet the challenges of large-scale electronic publishing, XML is also playing an increasingly important role in the exchange of a wide variety of data on the Web and elsewhere.

Appendix E
Bibliography

This appendix references standards and other documents, books and Web links that may be helpful to users of PC Audio Test.

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