Testing Audio Performance in Multimedia Computers

By Thomas E. Mintner, Audio Precision

Since its inception, the capabilities of the PC have been continually growing-and one of the latest brings audio and video technology together. As this transforms computers into multimedia communications terminals and audio/video program sources, the performance of high-quality paths for transporting the audio content must be ensured by thoroughly testing the computer audio systems.

Several factors complicate the computer audio-performance equation:

- High consumer expectations for audio quality are based on benchmarks of successful consumer audio products such as the compact disc.
- The digitally noise-contaminated environment of a PC chassis is among the most difficult in which to place an audio circuit.
- The audio signals in question appear at various times both as analog and digital signals and as digitized sound files within the computer.

A typical PC audio system includes either a plug-in sound card or motherboard audio hardware. Essentially, it is a digital audio recorder playing from digitized files or recording to them. It operates via input and output subsystems that are part of the overall computer audio-system hardware.

Consumer sound cards also include the capability to generate various synthesized instrument sounds and sound effects. This synthesis function is usually handled either by a special-purpose frequency-modulation synthesizer or by wave-table synthesis. But in any case, this is a separate signal-generation function not related to the basic input/output functionality of the sound system. Some of these functions now may be implemented with single IC subsystems, although premium systems tend toward more complex designs based on individually selected components.

Output Subsystem

Audio cue sounds, such as the Windows startup fanfare, use the output portion of the sound system. System software plays the digital audio file back into the digital-to-analog (D/A) converter of the output section. The digital audio rep-

Flexible Audio Test Set

Figure 1.

A/D and D/A Audio Analyzer

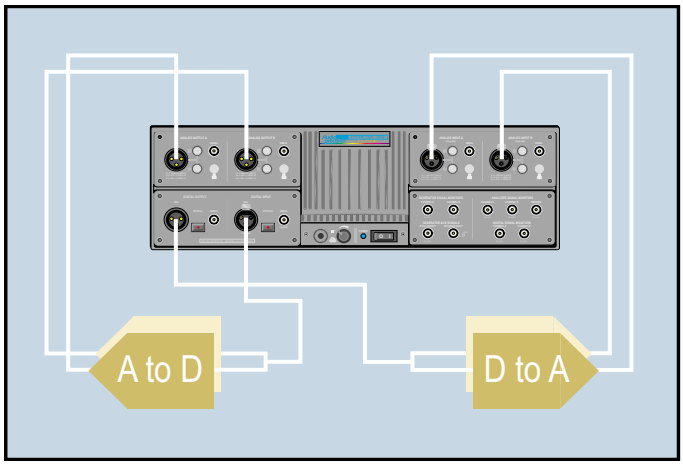

Figure 2.

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Multitone Signal Test Technique

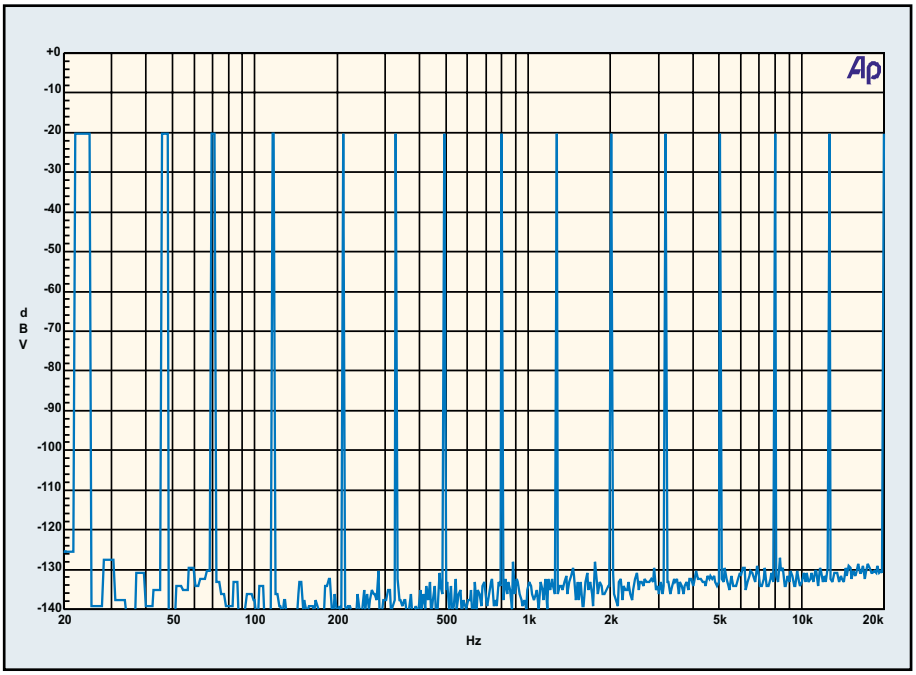


Figure 3.

resentation is converted into analog audio that is sent out through analog switching and processing circuits to drive headphones, small loudspeakers or another audio device.

The overall quality of playback is the testing concern here. Both the D/A converter and the associated downstream circuitry are tested for distortion, frequency response and noise. Speakerlevel outputs may be tested for distortion at rated power, and attached loudspeakers may be tested to measure their response with quasi-anechoic techniques such as maximum-length sequence testing. All of these tests may be performed with a single sufficiently flexible audio test set (Figure 1).

Input Subsystem

Recording a voice message or a sound file to be attached to a text message uses the input section of the computer sound system. Better systems include a separate low-level microphone input and a higher-level "line" input, the former passing through a microphone preamplifier stage. These signals pass to the analog-to-digital (A/D) converter for conversion into digitized records.

Independent A/D and D/A Testing for Design and QC

During design, the A/D and the D/A halves of the system must be tested independently. This requires an audio analyzer with the capability to generate and measure both analog and digital-domain audio signals (Figure 2).

For instance, to test an output subsystem (D/A), a digital audio signal must be available (either as a wave file or through a direct electrical connection ahead of the converter) to the D/A converter. Then the analog output must be measured for total harmonic distortion, noise or frequency response.

For this type of testing, there may be a hardware insertion point where the necessary digital signal can be injected. If not, an available digital-domain signal may be converted and stored into a compatible waveform file. In this case, the sound subsystem is tested as part of a functioning computer system. The waveform file is selected, played and converted to analog, then measured by the audio analyzer (see sidebar).

For input (A/D) subsystem testing, the audio test set supplies an analog signal, with the analysis and measurements made directly from the digital domain. Again, this is accomplished either by using a direct connection or by storing and measuring the resulting digitized audio. For production testing, it may be more efficient to test both halves together as an analog-to-analog loop (AD-D-A).

Multitone stimulus vs Conventional Test signals

Because of the need to measure performance at different frequencies, conventional testing uses stepped or swept frequency signals and analyzer settings to measure frequency response, distortion and noise at many points. However, a different and novel class of test signals well suited for this application is the digitally generated multitones. These signals consist of multiple sine waves of known amplitude and phase (Figure 3). By stimulating the DUT with a special class of synchronous multitone signals, a single acquisition and subsequent frequency -domain analysis provide simultaneous frequency response, distortion and noise measurements of the DUT.

The multitone signal is more program-like than standard test signals so it provides a more realistic stimulus exercising the channel

This multitone test technique has other benefits. The multitone signal is more program-like than sine wave or other standard test signals so it provides a more realistic stimulus for exercising the channel. Because all data points for all measurements are acquired simultaneously, the test speed is increased dramatically.

Some systems that use this technique extract the noise measurement independ-

ently, in full presence of the signal. Measuring noise in this manner is particularly useful for digital systems, where the character and level of the noise floor may be highly signal dependent.

Production Testing

Production testing may use either a digitized-sound-file approach or a combination of the input and output subsystems in one loop with an analog input and analog output. Multitone signals may be used in either test scenario.

Loop testing requires either a software or a hardware provision for connecting the digital data output of the A/D subsystem directly to the input of the D/A subsystem (A-D-D-A).

When multitone testing combines with input-to-output loop testing, a complete summary of system frequency response, distortion and noise may be obtained in less than I s. Also with this input-output loop, the measured results reflect the total record-play performance specifications of the finished product.

An audio test set capable of both dualdomain operation and digitized wave file import and export can perform all combinations of computer sound-system testing for both engineering and production needs.

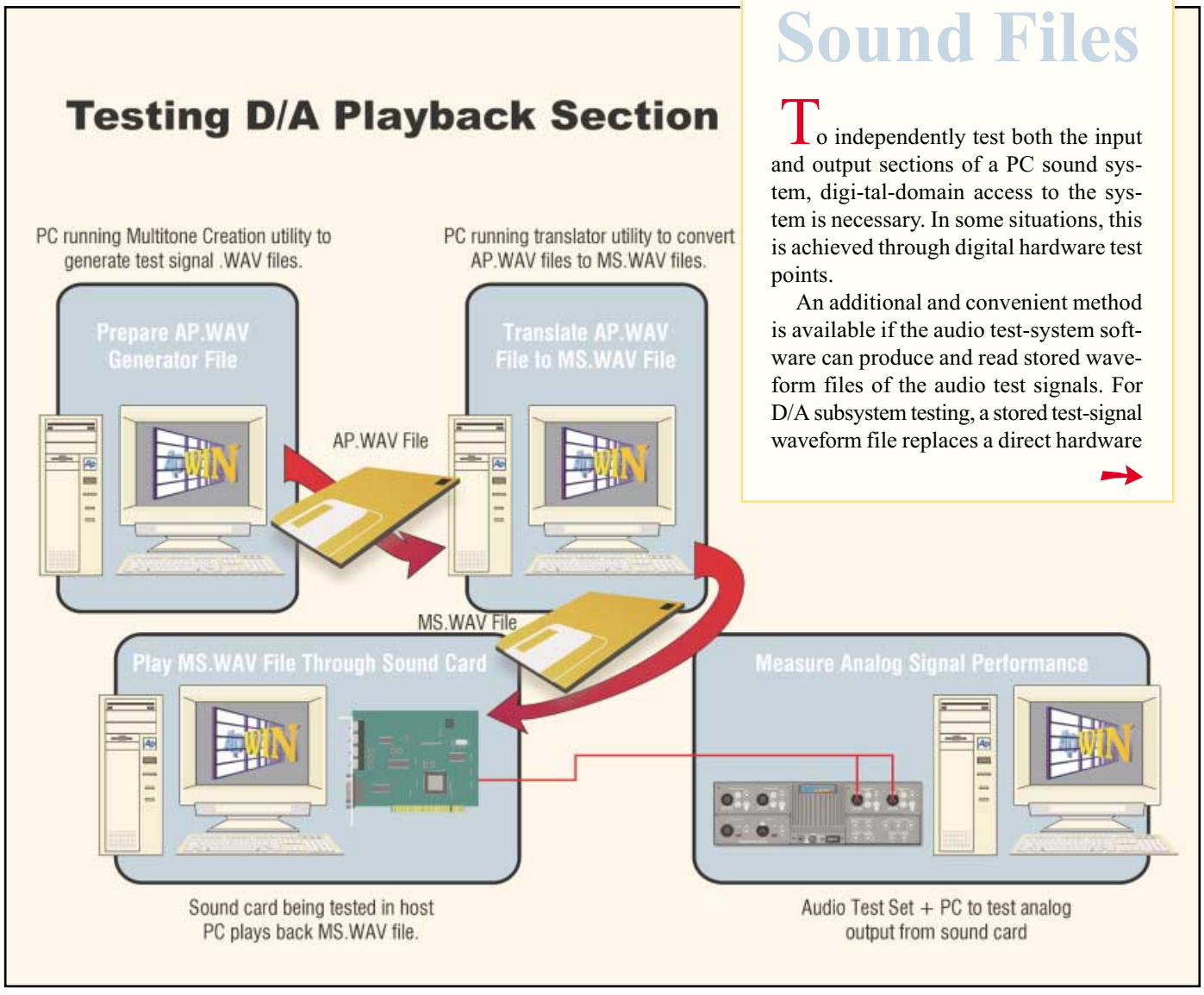
About the Author

Thomas E. Mintner is the U.S. Director of sales and marketing at Audio Precision. Before joining the company1988, he was vice president and general manager of Studer Revox America.Mister Mintner's formal training was in music & physics at Northwestern University. His early career included a fellowship and a professional staff position at the Center for New Performing Arts of the University of Iowa where he was involved in commercial recording, audio for film, and video. Audio Precision, P.O. Box 2209, Beaverton, OR 97075, (503) 627-0832.

PC Sound Files

To independently test both the input and output sections of a PC sound system, digi-tal-domain access to the system is necessary. In some situations, this is achieved through digital hardware test points.

An additional and convenient method is available if the audio test-system software can produce and read stored waveform files of the audio test signals. For D/A subsystem testing, a stored test-signal waveform file replaces a direct hardware



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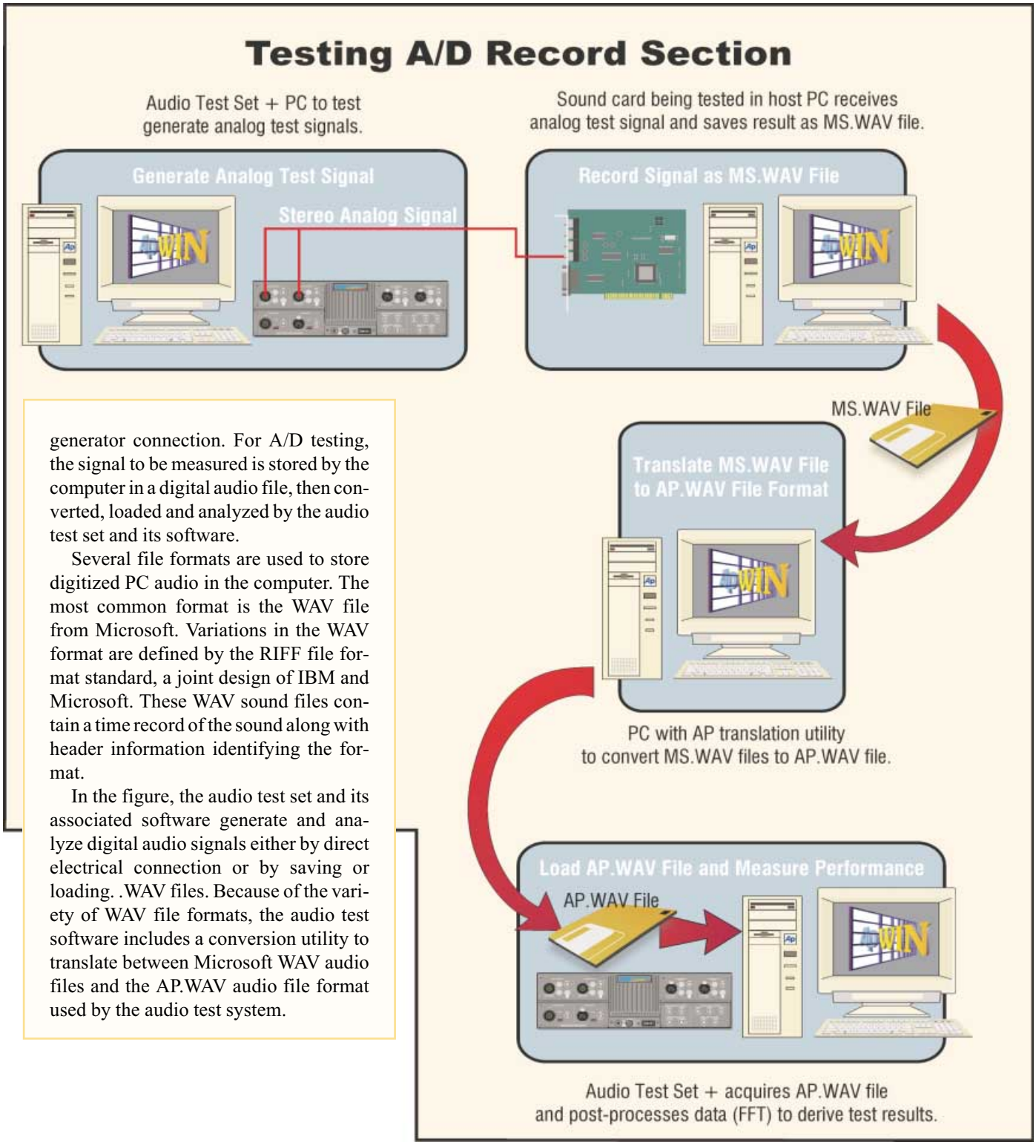

generator connection. For A/D testing, the signal to be measured is stored by the computer in a digital audio file, then converted, loaded and analyzed by the audio test set and its software.

Several file formats are used to store digitized PC audio in the computer. The most common format is the WAV file from Microsoft. Variations in the WAV format are defined by the RIFF file format standard, a joint design of IBM and Microsoft. These WAV sound files contain a time record of the sound along with header information identifying the format.

In the figure, the audio test set and its associated software generate and analyze digital audio signals either by direct electrical connection or by saving or loading. .WAV files. Because of the variety of WAV file formats, the audio test software includes a conversion utility to translate between Microsoft WAV audio files and the AP.WAV audio file format used by the audio test system.

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