SPOTLIGHT

Soundcard-Based Production Line Loudspeaker Test

By Steve Temme, Listen Inc.

Quality and reliability are critical factors for success in the audio industry. In today's global manufacturing environment, product testing is more important than ever, and products built in low-cost countries must be tested to the same standards as those manufactured in the US and Western Europe.

Peerless, one of the world's leading manufacturers of high-end audio speakers, produces over half a million loudspeakers a year. Peerless belongs to the Danish Sound Technology group (DST), together with Vifa and Scan-Speak. Their headquarters in Karlslunde, Denmark, still produce a majority of the speakers, and the DST manufacturing facilities in China produce a growing number of speakers.

Every single speaker that Peerless manufactures is tested for acoustic quality using SoundCheck™, a soundcard-based electroacoustic test and measurement system. This offers significant advantages over conventional hardware-based systems including fast and simple production line use, low capital expenditure and easy analysis and sharing of test specifications and results (*Photo 1*).

Peerless has manufactured loudspeakers in Denmark since 1926, and in 1995 the former Vifa-Speak (now DST) established an additional manufacturing facility in Panyu, China. In 2002, Peerless established a second facility in Xiaolan, China. These modern facilities offer cost-effective, high-quality manufacturing to supplement the output of the Danish factory.

Peerless conducts 100% quality testing of its products, and tests to exactly the same standards regardless of where the product is manufactured. In the Xiaolan facility, SoundCheck is also used for R&D work where a dedicated SoundCheck system measures frequency response and Thiele/Small parameters in a large 2pi room. With production lines several thousand miles apart, using the same test setup and equipment simplifies quality control (*Photo 2*). As Carsten Tinggard, the engineer responsible for the test systems, explains, "Our reputation is built on quality and reliability. Therefore, every loudspeaker that Peerless manufactures, either here in Karlslunde, or in China, is 100% tested as it comes off the production line using SoundCheck electroacoustic test software."

Loudspeaker Testing Using SoundCheck™

SoundCheck is a soundcard-based test system. It uses high-end pro-audio soundcards in conjunction with sophisticated analysis software to rapidly and accurately measure loudspeaker quality. The entire test, from stimulus generation to measurement and analysis, takes as little as a few seconds. This flexible platform allows Peerless to adapt and customize tests to suit the large number of different types of speakers that it manufactures.

An optimized stepped-sine excitation or Stweep™ is used to test the various electroacoustic parameters. Unlike most digitally-generated stepped sine sweeps, the Stweep changes frequencies at an integer number of cycles and continuous phase, minimizing transducer ringing and test time. A Brüel & Kjær microphone detects the signal from the loudspeaker and the soundcard captures the data, which the software subsequently analyzes.

A variety of speaker performance characteristics are measured in parallel, including frequency response, impedance, harmonic distortion, rub and buzz, Q at resonance, and resonant frequency of the loudspeaker (*Fig. 1*). Once the loudspeaker passes the basic test, a more detailed test is performed. This involves a sweep at high power, which focuses on the critical frequency-response ranges for a specific model

PHOTO 1: Soundcard-based system for testing drivers (Photograph courtesy of Bruel & Kjaer).

PHOTO 2: Production. (Photograph courtesy of Peerless).

in order to reduce the sweep time.

Peerless manufactures over 200 different types of drivers, varying in size from 4″–12″. Although each has a different test template, there are three basic reference test sequences set up in SoundCheck: one for woofers, one for mid-range units, and one for tweeters. These three basic sequences are modified for each different type of loudspeaker. Because they are based on the same core test script, setting up a large number of tests was relatively quick and simple because the test could simply be modified—rather than reprogrammed—for each product.

Although SoundCheck is sophisticated enough for R&D laboratories, it is designed with high-speed production testing in mind. Most loudspeaker manufacturing staff do not possess the same level of acoustics knowledge as R&D engineers, yet it is important that production-line speakers sound the same as those designed and tested in the laboratory. To facilitate this, SoundCheck is configured with various levels of operator control (engineer, supervisor, production line, and so on). This means that complex tests developed in the laboratory can be configured for one-touch operation and simple PASS/FAIL flags.

Peerless takes full advantage of this facility, as Carsten Tinggaard explains, "The production-line test staff are not acoustics experts. The SoundCheck user interface is very simple and shows a PASS/FAIL indication and a graph is also displayed. In the event of a loudspeaker failing the test, this indicates the probable cause of the problem and our production staff becomes experienced in fault diagnosis and classification. Analysis of the test data also shows where problems with rub and buzz occur. It's a very useful tool for production line management."

SoundCheck was designed by electroacoustic engineers who fully understand the rigorous demands of the production environment, and it includes many advanced algorithms to ensure that acoustic parameters are accurately measured. For example, when measuring distortion and noise, SoundCheck uses a proprietary algorithm that measures the distortion separately from background noise—and can measure any number of harmonics simultaneously. This is a significant benefit when making measurements in a noisy environment, such as on a factory floor.

SoundCheck is easily integrated into existing production lines and interfaced to existing test software such as real-time SPC (statistical process control) programs. Testing is controlled automatically or manually using peripheral devices such as barcode readers, footswitches, digital devices via an RS-232 or IEEE-488 interface, digital input/output cards and PLCs (Program Logic Control).

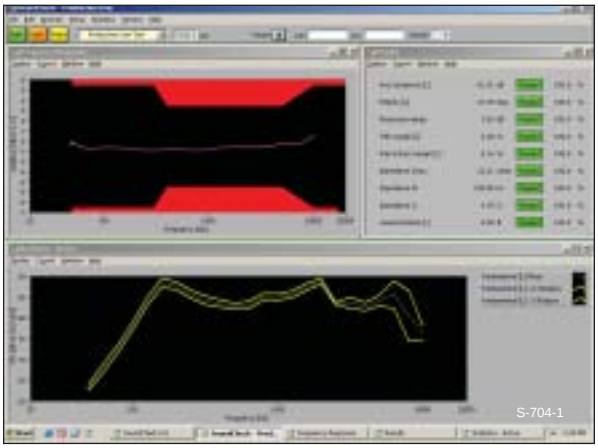

FIGURE 1: Typical SoundCheck pass/fail display.

Soundcard Advantages

A soundcard-based electroacoustic test system uses a high-end pro-audio soundcard on a standard computer to play and record test signals—rather than proprietary (and often costly) front-end data acquisition systems. The whole test, including calibrating and setting the parameters, generating the signals, collecting the data, processing, and analyzing the information, is carried out through software. Virtual instruments included in the program, such as signal generators, multimeters, oscilloscopes, spectrum analyzers, and real time fractional octave analyzers, eliminate the need for costly and high-maintenance additional hardware.

Test results output electronically to standard electronic formats, and can be imported into databases. A soundcard-based system is compact and portable; all that is required (in addition to the computer and soundcard) is a microphone to measure the sound and a power amplifier to power the loudspeaker under test. This portability is a valuable asset in today's global manufacturing environment.

The software-based nature of such a system means that it offers increased flexibility over conventional hardware systems. The same system can either be fully interactive for R&D applications, or configured for one-click operation and simple pass/fail reporting for production line use. The true benefits occur when the same system is used for both, because production can exactly replicate the tests carried out in the laboratory.

A common concern is whether a soundcard will provide comparable results to traditional data acquisition systems. Pro-audio soundcards typically use the latest and most advanced A/D and D/A converters found on the market, and typically provide over 100dB signal-to-noise ratio with frequency response of better than ±0.25dB to 40kHz and above. This means that the results achieved using a soundcard are virtually indistinguishable from those obtained with a conventional hardware data capture device. With the combination of advanced test programming and ease of use that software-based solutions bring to production-line testing, they present a viable and cost-effective alternative to conventional systems.

For detailed specifications on two high-quality pro-audio soundcards, visit www.digitalaudio.com and www.lynxstudio.com/lynxtwospecs.html.

Other Applications

Although the main application area for SoundCheck is loudspeaker testing, it is also widely used for testing headsets, telephones, microphones, hearing aids, crossovers, and audio electronics.

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