

Testing Audio Devices

TECHNICAL BRIEF

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Summary

Some engineers need to qualify audio devices for the Windows logo while others are designing theatre-quality sound devices for stage shows or for less expensive (but still good quality) automotive audio systems.

A human ear that is reasonably young and has not suffered too much blasting from high sound levels can detect audio frequencies ranging from about 20 Hz to 20 kHz. Thus this is the range most often used for testing. Modern electronic test equipment can easily produce these frequencies for use as test signal inputs; or capture them, to analyze the quality of audio output.

Generating Test Signals

There are a wide variety of tests for audio devices. The simplest is the input of a single frequency sine wave. A more common test is a swept sine wave which covers a range of frequencies. It is also possible to test device response to a sudden impulse. In some cases audio devices are controlled via a serial buss such as I²S, or in an automotive system via the CANbus. It may be desirable to test such systems by sending serial data streams which activate functions of the audio system. All these cases require a signal generator. Instrument's such as LeCroy's WaveStation or ArbStudio can generate signals ranging from a short impulse, a burst or a continuous signal. The signal can be a standard shape (pulse, ramp, sine wave, etc.), a sweep of frequencies, a controlled amount of noise or an arbitrary waveform. It is even possible to capture a real-world waveform such as music or a serial data command, edit that signal by adding noise or glitches, and then reproduce the signal. Figure 1 shows an example of setting up a WaveStation to produce a swept frequency sine wave which starts at 10 Hz and sweeps through the frequencies up to 30 kHz. This signal can be sent a single time, several times or it can loop continuously.

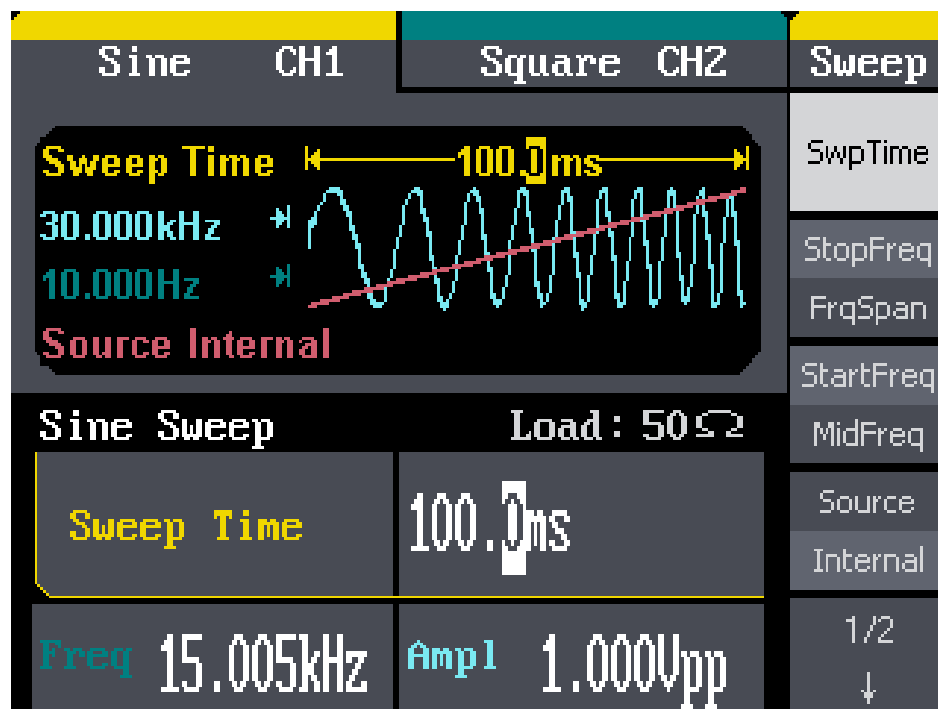


Figure 1: Setting up a WaveStation to produce a swept frequency sine wave. The instrument is easy to control from the front panel or via PC software

Capturing, Decoding and Characterizing Signals

Several types of test equipment can be used to capture and measure audio signals. Spectrum analyzers can measure the frequency content of a signal. Because they have a dynamic range over 100 dB these instruments are well suited to finding small amounts of signal energy in the presence of much larger frequency spikes at primary frequencies. Digital oscilloscopes are better suited to testing the flatness of the response of an audio system. A scope samples the signal and performs a Fourier transform which measures frequency content from DC to a frequency equal to half the sampling rate (the Nyquist frequency). Some modern oscilloscopes can generate a one million point FFT analysis that shows the flatness of the response of an audio device with much more resolution and precision than a spectrum analyzer. For this type of measurement it is important to select an oscilloscope with a long acquisition memory and the capability to perform an FFT on a long record length.

Figure 2 shows the use of an oscilloscope that can decode audio signals being transmitted via a serial data protocol.



Figure 2: A short zoomed detail of a serial data stream of an audio signal is decoded in the top trace. The two bottom traces are analog waveforms of sound corresponding to the values in the digital waveform

The top trace is a zoom detail of the serial data stream which is being decoded into hex values. Parameter 1 (P1) and parameter 2 (P2) have been defined as the values of the data in the serial data stream for the left and right channels of audio information. The two lower traces, F1 and F2, show tracks of those decoded values. This allows the audio information to be viewed as a waveform and even played through headphones or speakers. An engineer can use this method to view and hear the effects of clipping, glitches and other problems. This type of capability is very useful when designing or debugging audio components/systems that incorporate serial data methods to control the device or to encode the audio information. The same sort of decoding and tracking can be performed for the values in a CANbus data stream used in automotive applications.

Recommended Equipment

Both the LeCroy WaveStation and ArbStudio can produce standard functions (ramp, sine, pulse, etc.) and arbitrary waveforms. Both are able to import real-world waveforms that have been captured by an oscilloscope. Both standard functions and arbitrary waveforms can be edited to add noise, glitches or other features to the signal. The WaveStation is better suited to producing shorter, simpler waveforms because it has a shorter memory than the ArbStudio.

Many types of oscilloscopes that may be used to test audio signals. One product line that is well suited is the WaveSurfer from LeCroy. It can perform an FFT of up to one million points when spectrum analysis is needed and, with the addition of the AudioBus option, can decode I²S, LJ, RJ and TDM protocols. For automotive applications there are also options to decode CANbus, LIN and FlexRay.

Summary

The test, characterization and debug of audio devices can be achieved more quickly and thoroughly using the right type of instrumentation. The generation of test signals can be accomplished with function/arbitrary signal generators. Digital oscilloscopes can view the signal in both the time and frequency domains. Optional packages are available for triggering on and decoding serial data streams which is very useful for test of devices that use serial protocols.