ADC fit for an audio test platform

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Audio is being integrated into almost every electronic device, with a much wider variety of media sources available to consumers today than ever before – all with high-fidelity audio delivery. Gone are the days of static and unwanted distortion in audio systems, and even with the move to the Cloud for audio playback, streaming services offer listeners high-fidelity music. The audio space now requires more memory, more processing power, greater accuracy and better definition, yet in smaller packages. With voice recognition, the ability to distinguish a vocal command from a noisy environment will require high-quality hardware embedded in the devices. Hence, the key will be the dynamic range achievable and the ability to filter out noise and interference.

This growing number of audio modules has also led to an increased need for audio test platforms that offer multifunction flexibility and high-fidelity performance.

In search for a solution

Incorporating these requirements into a modern audio test platform comes up against limiting factors, including cost, size and power dissipation. In general, ADCs with 24-bit resolution and above are used for high-fidelity audio in the audio test space for increased dynamic range. For signal integrity, low distortion and excellent noise immunity are also required.

One product that can help ease these common constraints is the AD7768 from Analog Devices, a multichannel, 24-bit, Σ-Δ ADC. It is available in both 4- and 8-channel versions and, due to its SINAD performance, it's a proven fit for the audio test space. The AD7768/AD7768-4, with its multiple channels, allows a smaller system with increased channel density, keeping channel-to-channel crosstalk to a minimum, while allowing simultaneous testing of different devices.

Test case

To explore this ADC's capabilities, typical audio tests have been carried out to measure the performance of various consumer audio devices. The main test uses the AD7768 evaluation board, the EVAL-AD7768FMCZ, in conjunction with the SDP-H1 platform. Many possible test tones were considered, including IMD (intermodulation distortion) tones, logarithmic chirps and level tests.

The two test tones chosen were:
1. 1kHz sine wave at –60dBFS, useful for dynamic range tests since it keeps the device from muting, which artificially quiets the output.
2. IMD SMPTE test, 60Hz/7kHz, 4:1 (12dB ratio), –20dBFS. The IMD test shows nonlinear distortion products, produced as a result of multiple tones mixing. In this case, the 7kHz signal is modulated by the 60Hz tone at 7kHz, ±60Hz.

To tune the AD7768 to the required bandwidth, we must first make a few calculations to determine the required master clock (MCLK) and decimation rate. The MCLK used is 12.288MHz and the decimation rate is ×64 to give an output data rate (ODR) of 48kSPS. Other combinations could be used for a power vs bandwidth trade-off.

The setup is shown in Figure 1. It uses the EVAL-AD7768FMCZ board, AC-coupled from the on-board SMB

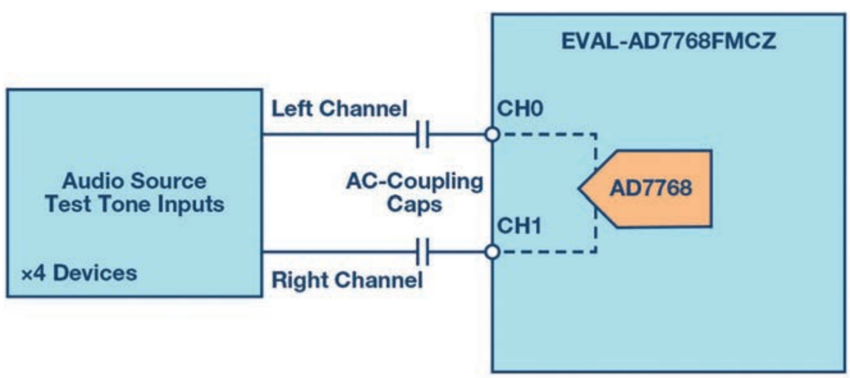

Figure 1: Connection diagram

Device	Frequency (Hz)	Dynamic Range (dB)	IMD Second-Order (dB)	IMD Third- Order (dB)
Known good source	1000.5	101.2	–143.4	–139.2
Mobile phone	1000.5	101.2	–121.3	–125.8
Laptop	1000.5	89.6	–119.4	–119.5
Mobile phone over Bluetooth link	1000.5	93.7	–110.6	–118.3
MP3 player	997.6	99	–94.9	–104.7

Table 1: Test-tone results

connectors to the audio device. Up to four stereo outputs on the eight channels can be tested at once. Further circuit optimisation can be performed, for example by adding a high-pass filter to remove noise below 20Hz.

Table 1 shows the results for both the low-amplitude input signal and the IMD test, which vary significantly from device to device. It was quite interesting to observe that the inexpensive MP3 player showed good dynamic range but, under the IMD test, significant distortion was introduced. The frequency output of this device demonstrated lack of quality and its output drive capability limited the maximum testable IMD level. Hence, for comparison purposes, we limited the test tone to –20dBFS for all devices.

The audio output of the laptop has many different driver and processing options. These have been developed to match the response of the human ear for a more pleasant sound, but result in some frequencies being altered. Hence, when these effects are turned off, the laptop shows the worst dynamic range, whilst sounding just as good as the other sources.

Figure 2 shows the IMD range seen across the devices from the known good source (orange) to the poor-quality MP3 player (green). The IMD products are clearly visible at 7kHz and ±60Hz for both the MP3 player and the phone.

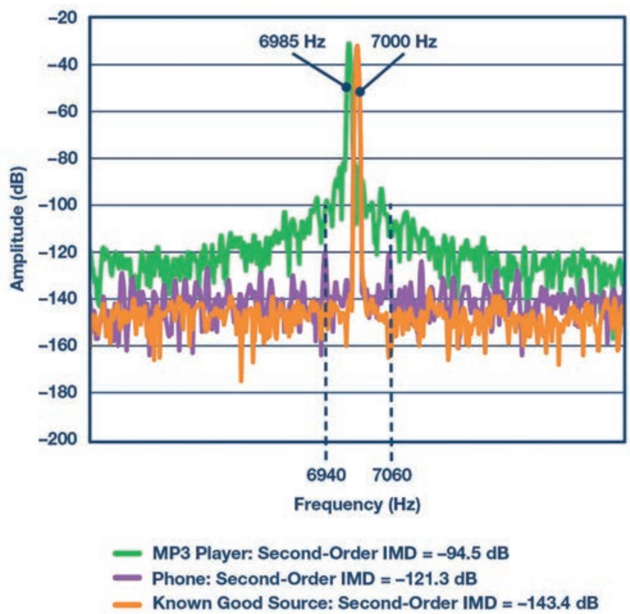

Figure 2: IMD SMPTE test samples, 7kHz input

Differentiating factors

The AD7768/AD7768-4's maximum ODR is 256kSPS. This ODR can be tuned to typical audio bandwidths of 48kSPS, 96kSPS or 192kSPS, by adjusting the MCLK and/or decimation rate, depending on the application.

The audio space now requires more memory, more processing power, greater accuracy and better definition, yet in smaller packages

Many modern test platforms are moving toward modular systems where thermal requirements are a concern. The AD7768/AD7768-4 allows the trade-off between signal bandwidth or dynamic range for power consumption, allowing a wider range of uses. This flexibility is shown in Figure 3, which plots dynamic range vs ODR.

Having more channels is also an advantage, for the following reasons:

1. Test speed

Eight channels or four stereo devices can be tested simultaneously, effectively reducing test duration and cost by a factor of four.

With a rising number of audio modules in our environment, future audio test platforms will increasingly be mindful of the requirement for speed, and the economies therefrom.

2. Performance

End-system performance can be further boosted by combining multiple channels; say, combining four channels into one will allow up to 6dB improvement in dynamic range over those shown in Figure 3.

3. Smaller packages

A multichannel audio platform may have size restrictions because of increased channel densities, limited system- or factory-floor space, or simply a move to modular benchtop instrumentation. Combining eight ADCs into one package allows the test platform to follow this trend toward smaller devices. EW

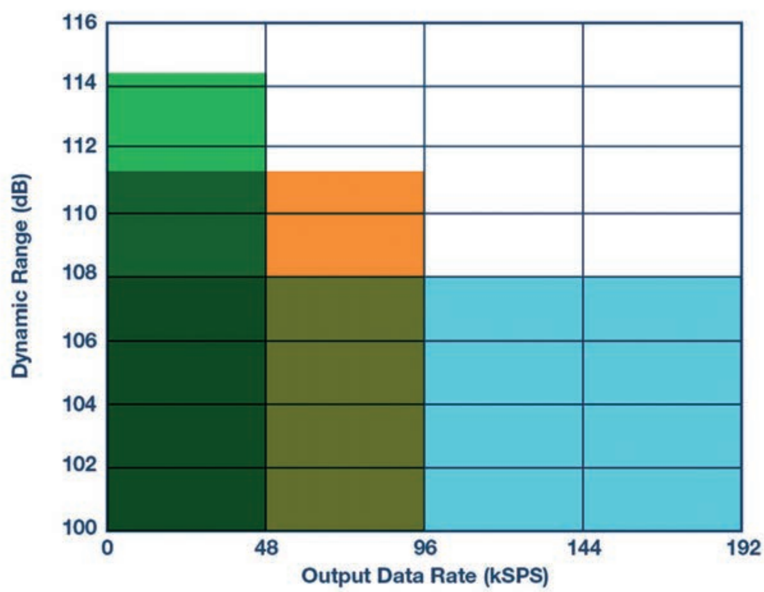

Figure 3: Dynamic range vs ODR (per channel)

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