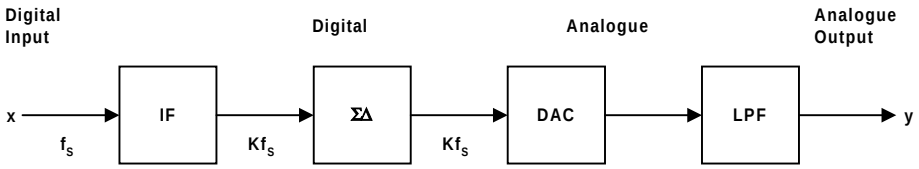
Wolfson Microelectronics' Audio DAC Architecture

Audio digital-to-analogue converters (DACs) have been available for sometime using sigma-delta conversion techniques. Although designers have learnt to overcome some of the potential problems that are inevitable in their implementation, Wolfson has made some significant improvements that correlate extremely well with higher sound quality and without incurring additional cost.

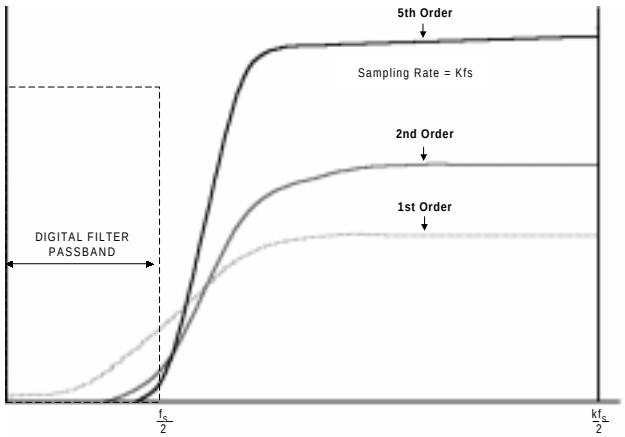
Audio DACs typically consist of four separate processing elements. The input audio data is filtered using an interpolation filter to remove out-of-band images. A sigma-delta modulator processes the interpolated data to produce a digital bit stream suitable for conversion into an analogue signal. The digital bit stream is passed to a DAC. The output of the DAC is then input to an analogue filter to recreate an accurate representation of the music signal.



IF: Interpolation filter
ΣΔ: Sigma-Delta Modulator
DAC: D/A Converter
LPF: Analogue low-pass filter

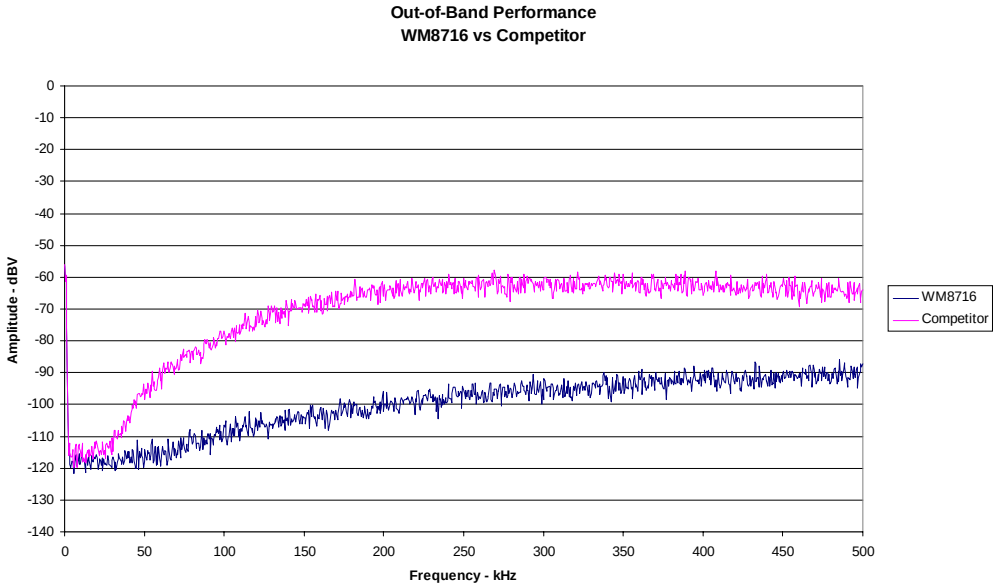
Block Diagram of a ΣΔ DAC

The first sigma-delta converters were built around a high-order modulator and a 1-bit DAC converter. Although these designs are insensitive to component matching, the single bit, high order modulator results in rapidly rising out-of-band energy. This noise is difficult to remove without very high order analogue filters, which are expensive and deleterious for high quality sound reproduction. Wolfson uses a novel multi-bit sigma-delta design and a low order modulator to minimise the impact of these design limitations.

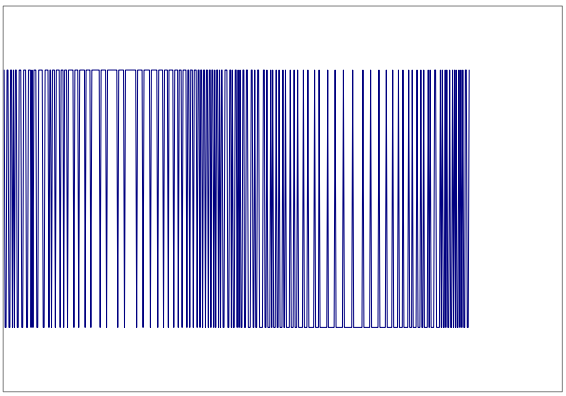


Noise Amplitude vs frequency for 1st, 2nd and 5th order, single-bit ΣΔ modulators

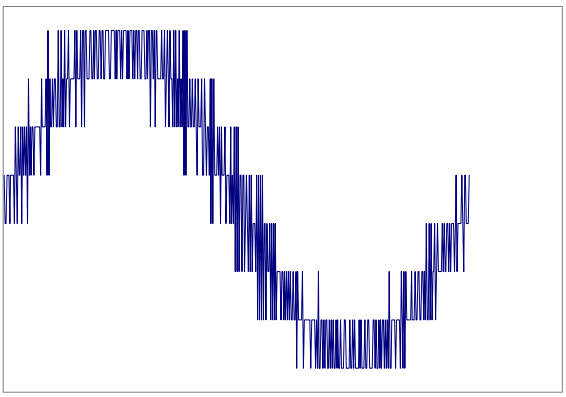
This can reduce the rapidly rising out-of-band noise by more than 30dB compared to conventional sigma-delta converter designs.



In the case of a 1-bit DAC, the output prior to filtering is a series of rectangular pulses. The filter must be capable of transforming this stream of pulses into an real analogue waveform, not an easy task. Furthermore, the 1-bit DAC converter is sensitive to clock jitter. Jitter in the oversampling clock translates directly into DAC errors, reducing the sound quality of audio DACs.

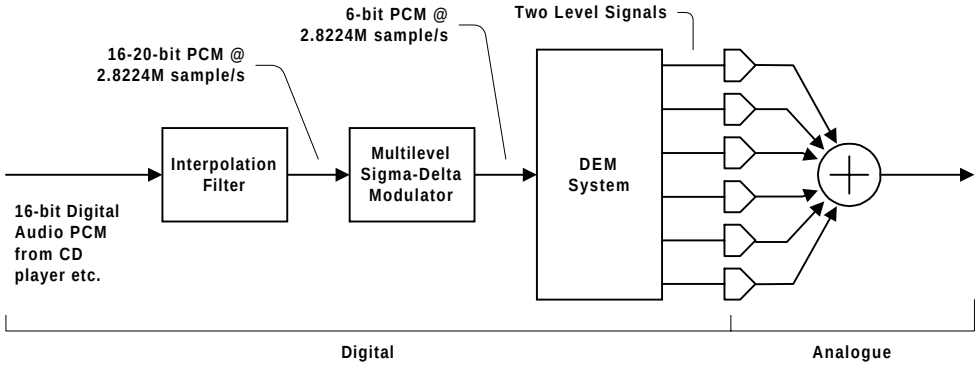


- 1-bit DAC has a two state DAC output of typically +/- V_{REF}
- Clock jitter causes gross errors increasing noise



- Wolfsons's multi-bit DAC decreases the magnitude of quantisation errors
- Errors induced by clock jitter are also reduced
- Results in reduced DAC noise and jitter sensitivity

The output from the modulator is passed on to a multi-bit DAC. Because the DAC is not inherently linear as in the case of a 1-bit DAC, a novel linearisation process called dynamic element matching (DEM) is used to remove resultant errors from the audio signal.



- The multi-bit sigma-delta DAC is constructed using multiple 2-level DACs
- Outputs are summed to provide an analogue output
- Scrambler selects appropriate combination of DAC outputs for good linearity

The output from the DAC now looks rather more like an analogue signal and it becomes a relatively easy task to effectively filter the output.

The use of a multi-bit DAC also accounts for the insensitivity of Wolfson's audio products to clock jitter, thus resulting in better sound quality. Whilst still a concern, a 6-bit multi-bit DAC architecture is intrinsically 64 times less sensitive to clock jitter than a 1-bit DAC.

In conclusion, Wolfson has specifically selected an audio DAC architecture that is designed to combine cutting edge performance with state-of-the-art sound quality. Moreover, this means that Wolfson audio products not only deliver world-class specifications but also benefits that whilst often not written in the data sheet are nonetheless just as critical to the discerning audio product designer.

WM8740 24-Bit Ultra High Performance Audio DAC

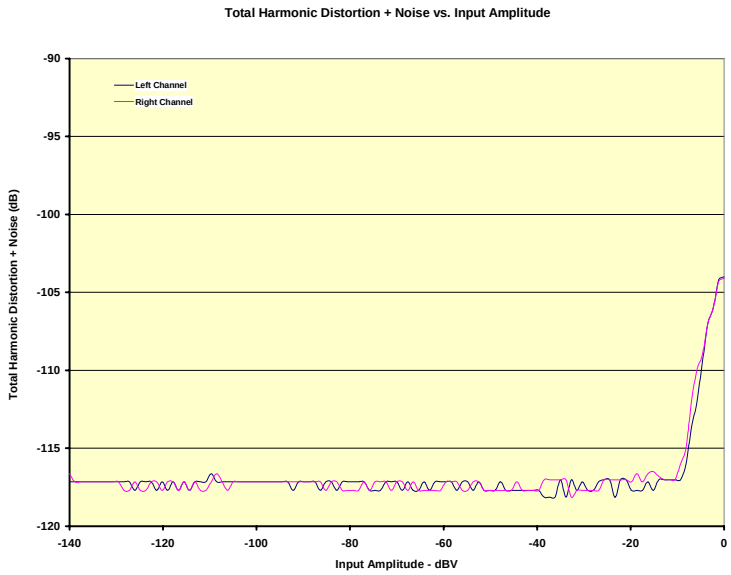
The WM8740 was designed specifically for ultra high performance audio systems. Achieving a state-of-the-art SNR of 117dB and a THD of –104dB (0.0006%) for a stereo 'A' weighted signal, the WM8740 is a showcase for Wolfson technology.

The WM8740 uses Wolfson's proprietary multi-bit sigma-delta converter architecture, which significantly reduce the out-of-band noise traditionally associated with most modern audio DACs. This feature combined with the high level of performance results in fewer external filter components and outstanding musicality.

With the launch of several new audio standards such as DVD-Audio, SACD and DVD-RW, high performance audio DACs are more desirable than ever. The WM8740 is the latest in a family of digital audio components designed for applications such as CD, DVD, home theatre systems and professional music equipment.

Features

- 117dB SNR ('A' weighted @ 48kHz)
- -104dB THD ('A' weighted @ 48kHz)
- Sampling Frequency: 8KHz – 192KHz
- Input Data Word: 16 to 24-bit
- Optional Interface to Industry Standard External Filters
- Hardware or 3-Wire Serial MPU Control Port Interface
- Differential Voltage Outputs



Applications

- CD Players, DVD Universal and DVD-Audio Players
- Home Theatre Systems
- Professional Music Equipment