DEQX™

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Speakers
the weakest link

DEQX™

As speaker designers and manufacturers, or high-end DIY audiophiles, we know that loudspeakers are the weakest link to the *'being-there'* reality that HD needs to deliver.

Despite eighty years of innovations, and the recent advent of consumer 24/96 HD media, 'HD-audio' is yet to arrive for the mainstream because passive uncompensated speakers can't deliver HD affordably.

'Active' speakers were introduced many years ago in the pro-audio world to improve this situation. Using separate amplifiers for each driver allowed for better crossovers and limited EQ, offering lower distortion, better dynamics and more accuracy.

However, active architecture alone still doesn't provide a quantum leap in the experience of sonic reality that consumers have come to expect from HD video for example.

As welcome as new 24/96 media may be for audiophiles, the improvement is subtle at best for most consumers, who have yet to hear the real contents of their CD or vinyl collection. This is largely a consequence of forcing eight to ten octaves of high power audio through one wire—challenging the already struggling mechanics of speakers to be as accurate as the signal driving them.

As even CDs can provide 'HD' on the best audiophile systems, the main problem can't be the media. So, for the rollout of HD-Audio we have started with the least requirement first: the HD-media. And as most good music recordings made in recent decades were mastered at 24/96, the important part of HD is up to us.

So, where's the line between Hi-Fi and HD-audio that consumers will respond to? In the move from SD-video to ever popular HD-video, it was roughly a four-fold improvement of pixel resolution and colour accuracy.

We find this four-fold (approximately) order of improvement over traditional speaker parameters also delivers a highly respectable HD 'being there' reality that average consumers want because it sounds 'real'. And you don't need to be an audiophile to recognise it.

Affordable passive speakers don't sound 'real' because they introduce: plus/minus 3dB frequency response; group-delay error sufficient to upset time coherence in the critical upper bass and midrange; typically a 2% minimum distortion but far worse modulation distortion; midrange-to-tweeter crossover distortion caused by non-linear filters; and uneven frequency dispersion that sounds unnatural in most rooms and limits the listening area.

Additional problems include: modulation distortion and phase errors caused by the crossover itself; amplifier modulation distortion caused by the need to drive ten octaves from heavy bass to subtle high frequency harmonics.

The solution: DEQX-HD

After a decade of research and development (and following two decades pioneering DSP for pro-audio) DEQX-HD™ corrects loudspeaker linear errors of frequency-response and group-delay in fine detail.

To minimise the non-linear errors of dynamic, crossover and modulation distortion, steep linear-phase crossovers are used for the mid/tweeter transition. The steep low pass filters also minimise beaming from bass and midrange drivers to provide even, natural sounding dispersion.

The ability to correct linear errors and quarantine driver resonances allows the use of affordable, very low distortion drivers. These drivers can't normally be used in passive designs due to problematic frequency response and resonances caused by rigid cones such as metal alloys.

HD = plus/minus 0.5dB frequency response

To correct frequency-response and group-delay, anechoic or quasi-anechoic measurements are made generically using DEQX-HD's integrated development software for each driver model, or for individual drivers for high-end implementations. The correction filters are integrated with the linear-phase crossovers using patented low-latency FIR/IIR real-time filtering to minimise floating-point DSP resources and minimise latency to allow synchronisation with video.

HD = negligible crossover distortion

For the mid/tweeter crossover, steep linear-phase crossovers at typically 48dB/octave to 90dB/octave are used. The problem of pre-ringing associated with steep linear-phase crossovers is compensated by the midrange's low-pass filter and the tweeter's high-pass filter's phase construction, so that pre-ringing is acoustically cancelled. The steep, phase-accurate, inaudible filters minimise dynamic and crossover distortion while largely eliminating midrange driver beaming.

HD = speakers that are seen but not heard!

DEQX-HD's less than 0.5% distortion target through mids and highs combined with more natural horizontal dispersion, accurate phase control and minimal crossover distortion lets speakers 'disappear' acoustically. With unobtrusive in-wall speakers, dramatic performance improvement is possible as installers can make in-situ, quasi-anechoic measurements and correction, integrating them with subwoofer room measurements.

For the low frequency crossover from midrange to bass driver, or bass/mid driver to subwoofer, linear-phase filters would add too much latency to allow synchronisation with video unless the video could be delayed. Fortunately, for this typically 80Hz to 200Hz crossover, minimum-phase filters are more tolerable psycho-acoustically than the mid/hi crossover, where additional latency will not be incurred.

HD = Active

Consumers are comforted to know that speakers claiming HD status will work differently than traditional hi-fi. Active 3-way, or active 2-way plus a subwoofer, demonstrate an architectural change that helps justify their HD status.

Active's other benefits include: no passive crossover distortion and reduced amplifier modulation distortion due to their limited three-to-four octave work load. Amplifiers can target their frequency range—allowing low, or zero, negative feedback to avoid the 'sterility' common to high feedback amps.

Why DEQX-HD™ ?

The choice of development and production related software and DSP hardware determines an HD system's performance.

In the case of traditional DSP crossover software, performance will be roughly equivalent to traditional active speakers. This is certainly better than passive but far from DEQX-HD™ capabilities.

Fortunately, the additional cost of DEQX-HD licencing is amongst the least expensive component in an HD-audio system.

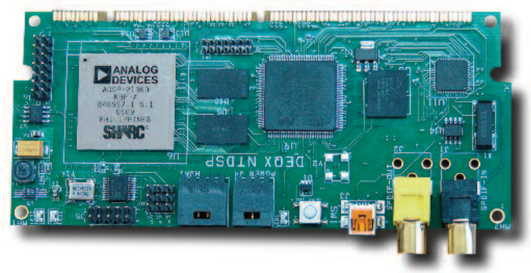
Committed to being the benchmark standard for HD-speakers, DEQX-HD™ is an integrated measurement, analysis and real-time processing environment that allows customised user interfaces to suit your systems.

Its wizard-driven operation is quick and can be easily used in a production environment where every speaker is measured and corrected individually. Usually however, entry-level and medium price HD-speakers would simply use a generic filter set.

The first step to implementing DEQX-HD™ is to hear the improvements possible from your existing passive or active designs. This will help choose the most appropriate hardware implementations for your systems.

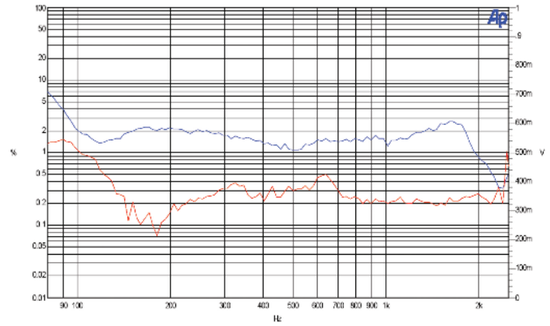
DEQX's HDP3 reference stereo pre-amplifier incorporates DEQX-HD™ 3-way active crossover outputs and is supplied with a DEQX calibrated microphone and DEQX-cal Windows-based measurement, analysis and real-time control software. Typically a PC notebook is connected to the HDP3 via its long USB cable to allow control at various listening positions.

DEQX offers custom hardware and software designs services and in 2010 will release a new range of lower cost OEM modules that can be purchased directly or licensed for in-house production.



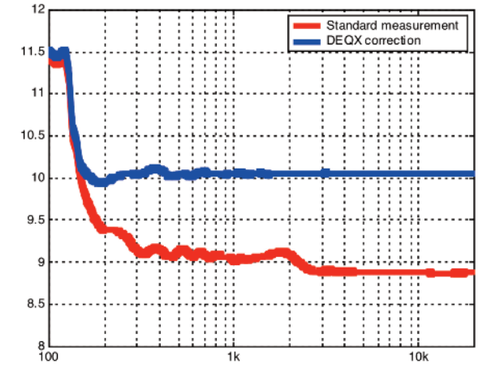
The NTDSP module is intended for systems where it can interface with high-end converter electronics and custom I/O requirements. Its third generation SHARC DSP provides 32-bit floating point precision, and contains eight hardware sample rate converters that don't impact DSP resources.

This module has USB and serial interfaces as well as SPDIF I/O. It also includes typically 32MB SDRAM and 32MB of FLASH RAM allowing storage of hundreds of sets of correction/crossover filters to cover a wide range of products.

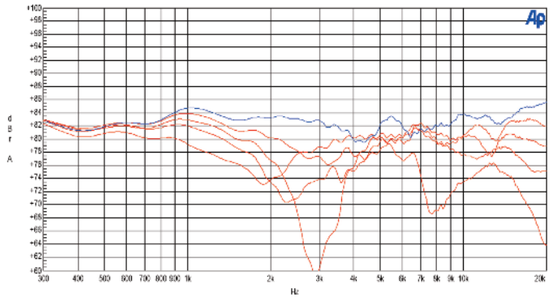


BLUE shows a traditional 5.25" woofer/midrange driver where typical THD for high quality passive loudspeaker system ranges from 2%–10%, in this case average is 2%.

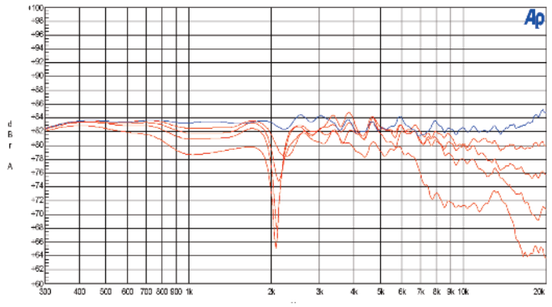
RED shows distortion in a DEQX-HD calibrated magnesium low distortion driver (SEAS) where average distortion is 0.3% THD 100Hz-3kHz, 1 meter on axis, 96dB SPL.



Group delay correction is focussed for the upper bass and midrange where it is most noticeable. RED shows normal speaker performance and BLUE shows DEQX-HD™ correcting all frequencies to a more coherent down to upper bass.
Nearly 1ms of correction has been required through the midrange and upper bass.



Typical passive 2-way bookshelf showing horizontal dispersion from 0-degrees to 60-degrees off axis.



Typical DEQX-HD™ 2-way bookshelf showing horizontal dispersion from 0-degrees to 60-degrees off axis.

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