

# DEQX Improves Speaker Sound Quality with MATLAB®

The sound clarity from even the most expensive, high-end speakers is compromised when they interact with a listening room or studio’s ambient acoustics. Professional recording studios, such as the famous Abbey Road Recording Studios in London, as well as electronics manufacturers and home theatre owners are perfecting the quality of their speakers with audio-correction technology from DEQX.

DEQX, an Australian digital audio technology company, produces audio-correction technology that provides detailed room measurements and tools that enhance room acoustics, improve speaker power handling, and create a wider soundstage. They use MathWorks tools to develop and test the measurement, calibration, and playback correction and equalization algorithms on DSP hardware, enabling users to calibrate loudspeakers for their rooms.

“Our goal is to make the speaker and listening room transparent to deliver the most high-definition audio experience,” says Brett George, software engineering manager at DEQX. “MathWorks tools are such an important component of our design process that I can’t imagine how we could have reached our goals without them.”

## THE CHALLENGE

DEQX’s audio-correction technology needed to enable users to measure their loudspeakers and rooms, and from those measurements create correction filters that improve the resulting sound from the speaker in a particular environment. With such a varied range of input data, their signal processing algorithms must be extremely robust.



DEQX Calibrated™ PDC 2.6 Digital Calibration Processor.

“It is difficult to reliably design a loudspeaker that is accurate across its entire bandwidth,” Mr George notes. “Furthermore, it is impossible to design an analog crossover that is steep enough to separate the interaction of each loudspeaker driver. We needed to design signal processing algorithms to correct these problems.”

Finally, in developing a product where there wasn’t much existing technology in the field, DEQX was under pressure to deliver the best product in the shortest timeframe—before their competitors.

## THE SOLUTION

Using MathWorks tools, DEQX developed custom speaker and room correction software, part of a range of products based on the calibration correction process. This process enables speaker designers to provide levels of accuracy and clarity in speakers to achieve the best possible reproduction of audio source material.

DEQX’s development methodology involves initial research, followed by a proof-of-concept and testing stage to confirm algorithms work as expected. After reaching a satisfactory solution, they develop and incorporate a real implementation into the existing software.

During the initial stages of software development, DEQX engineers used MATLAB® to develop and test algorithms that will run on their custom DSP platform. They wrote the MATLAB code in a similar way to the

### THE CHALLENGE

To develop an audio-correction technology that improves speaker and room sound quality

### THE SOLUTION

Used MathWorks tools to develop and test the measurement, calibration, and playback correction and equalization algorithms on DSP hardware

### THE RESULTS

- Reduced development time by months
- Awarded product of the year
- Accelerated testing process



MATLAB is the industry-standard tool for developing algorithms using a high-level language. The Signal Processing Toolbox also provided us with a great base of functions to begin our development, saving us months of time.



Brett George, DEQX

code that would run on the DSP. Using this method, engineers confirmed that the results were mathematically correct and avoided spending unnecessary time writing custom C code. They also used MATLAB to generate intermediate results to test the algorithms in a DSP simulator.

“We tested our ideas quickly and accurately with MATLAB,” says Mr. George. “MATLAB was such an important component of our design process that I can’t imagine how we would have progressed without it. Our only choice would have been to write our own version of it!”

Using MATLAB and the Signal Processing Toolbox, they implemented signal processing functions to determine which components would work on actual hardware before implementation. This helped them to evaluate the effectiveness and feasibility of their ideas before committing time to further development.

After developing their algorithms in MATLAB, engineers used the MATLAB Compiler to compile these algorithms into C++. The compiled algorithms were then integrated with the graphical user interface that they developed with C++. This approach enabled DEQX to take advantage of both languages—MATLAB for the mathematical algorithms and C++ for the user interface software.

“The integration between the compiled algorithms and Microsoft Visual Studio® is seamless,” says Mr. George. “We can change our MATLAB files, recompile them with the MATLAB Compiler, and link them again in Visual Studio.”

DEQX has already released the first version of their hardware and software. They are using MathWorks tools to develop a more efficient version of their firmware to work at higher sampling rates.

## THE RESULTS

- **Reduced development time by months.** “Developing the main algorithm in C++ to calibrate speaker measurements would have required us to write a linear algebra class library and a suite of signal processing tools,” says Mr. George. “MathWorks tools saved us 9-12 months of time by providing all those things and accelerating our algorithm development.”
- **Awarded product of the year.** *Electronic House* magazine has chosen DEQX Calibrated™ NHT Xd Loudspeakers as one of its 2005 products of the year for its technological innovation, outstanding features, and overall value for money.
- **Accelerated testing process.** “We need to test all our algorithms thoroughly,” says Mr. George. “Using MATLAB to generate a rigorous set of tests, we automate a lot of the testing processes and significantly speed up the testing process.”

To learn more about DEQX, visit [www.deqx.com](http://www.deqx.com)

### APPLICATION AREAS

- Algorithm development
- Application deployment
- Electronics
- Signal processing

### PRODUCTS USED

- MATLAB
- Signal Processing Toolbox
- MATLAB Compiler

[www.mathworks.com](http://www.mathworks.com)