Oxford Digital *MajEq* for Sonic Tuning in Consumer Equipment

Overview

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Oxford Digital EQ *MajEq* "Tuning" System for Consumer Devices

0. Executive Summary

This document describes Oxford Digital *MajEq* system for improving the sonic performance of consumer equipment via a "Tuning" process.

The unique selling points (USPs) associated with the *MajEq* system and Tuning methodology are:

- It provides automated frequency response correction and can be coupled with other effects (e.g. Bass Enhancement) to form a complete solution for sonic performance optimisation
- The Measurement System is included
- Measurements can also be taken by external systems (e.g. SysTune) and imported into the system
- A fixed DSP budget for equalisation and aesthetic tonal correction can be pre-defined (i.e. the number of bi-quads available)
- It makes extremely efficient use of the limited equalisation DSP in the device – up to 40% more efficient in terms of poles than a conventional parametric EQ
- Ability to fine tune the frequency response by hand via familiar controls (like filters, tone controls & parametric EQs) without using additional DSP
- Ability to layer additional EQ (Rock, Classical, Pop, Jazz, Regional sounds) without using additional DSP
- Fast workflow (hours or even days using conventional parametric EQs for response equalisation can be reduced to minutes)
- It allows deskilling of the task: Relatively unskilled people can produce good results
- It's a low latency, low processing budget solution
- Aspects of the *MajEq* system are covered by UK Patent Application Publication No: GB 2 458 631 A, International Patent Application Publication No: WO2009/112825 and UK Patent Application No: 0922702.6 .

1. Introduction

As the size and form-factor of consumer equipment such as handsets and TVs becomes smaller, it is more difficult to maintain the sonic performance at a reasonable level due to the use of small or micro speakers which are crammed into small acoustic enclosures.

Examples of equipment affected are shown below in Fig. 1:

Fig.1 Typical examples of consumer equipment requiring sonic improvement

The issues include:

- “Honky” performance due to resonances within the speaker/enclosure combination and poor cabinet damping
- Poor bass response due to use of small speakers, speaker apertures and enclosures
- Inability to reproduce adequate loudness due to use of low battery voltages & small speakers in portable/mobile equipment
- Difficulty in listening to material in noisy environments due to excessive dynamic range
- Widening the stereo image of speakers that are very close together
- Improving intelligibility of speech

Oxford Digital has wide experience in improving the sonic performance of such equipment and has been focussing on reducing both the time-to-market and skills level required for this usually very time consuming “tuning” process and providing extremely DSP efficient solutions.

This document describes the technology available from Oxford Digital for consumer equipment device tuning with particular reference to automation assisted EQ.

2. Tuning Process

2.1. Response Equalisation

2.1.1 The Issue

The response of a typical Accessory Speaker is shown below in Fig.2

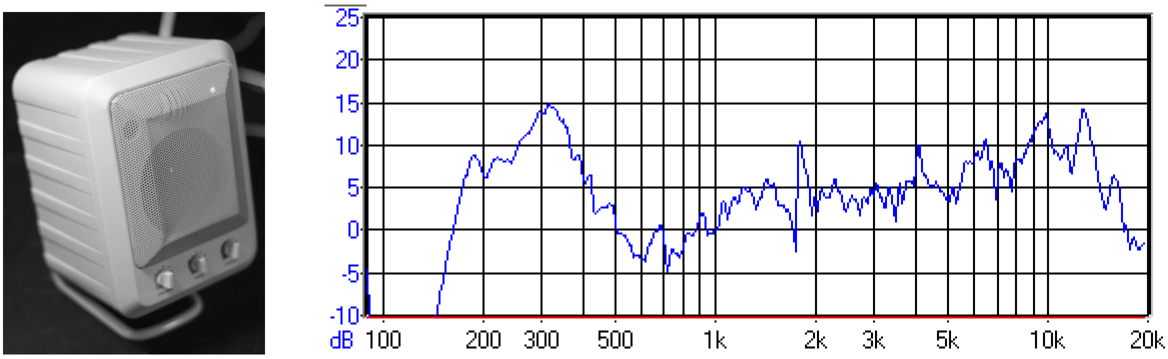

Fig.2 Typical Accessory Speaker and associated response.

The useful response of the speaker extends from around 160Hz to 15KHz, but within that band there are variations in level of up to 20dB.

When a decision is taken to improve the sonic performance of such a device by implementing correction in DSP, these variations are traditionally equalised using parametric EQs (Bell EQs) or graphic EQs. Both of these suffer from extreme interaction between the controls of one section and the next making adjustment a very time-consuming and skilled process which can take hours or even days to accomplish by a "Golden Eared" operator. In addition, graphic EQs have a very high processing requirement.

Some systems have been produced to automate this process by using FIR filters with a response calculated from the inverse of the measured speaker characteristic. This can speed up the process considerably, but at the cost of using huge DSP resources (~300 taps to get down to 160Hz in this case and which also introduces significant delay). In addition it's impossible to "fine-tune" the result by changing coefficients by hand. Any errors in the measurement must be corrected by adding additional EQ on top of the FIR DSP resources.

2.1.2 The Oxford Digital *MajEq* Solution

The *MajEq* system incorporates the following:

- Measurement system to capture the frequency response of CE devices including speakers and headphones
- Alternatively, measurements can be imported from external systems (e.g. SMAART, SysTune)
- Means to produce a correcting "target" EQ curve
- Means to select the useful band where correction should be applied (so as not to over-drive speakers outside their useful range - thus avoiding nasty noises and damage)
- Means to define a fixed DSP budget (e.g. 4 bi-quads)
- More efficient use of the DSP budget than conventional parametric EQs – up to 40% fewer poles for the same RMS error

- Means to automatically produce the correcting EQ curve with guaranteed convergence within a few seconds
- Means to “edit” the correcting response via familiar EQ controls (filters, parametric EQs) if it is desired to over-ride the measurement system – all within the same defined DSP budget
- Means to layer additional EQ (e.g. Classical, Pop, Jazz, Rock curves &/or regional sounds) – all within the same defined DSP budget

The *MajEq* system and use methodology is in the process of being patented.

A typical result produced by the *MajEq* system is shown below in Fig. 3:

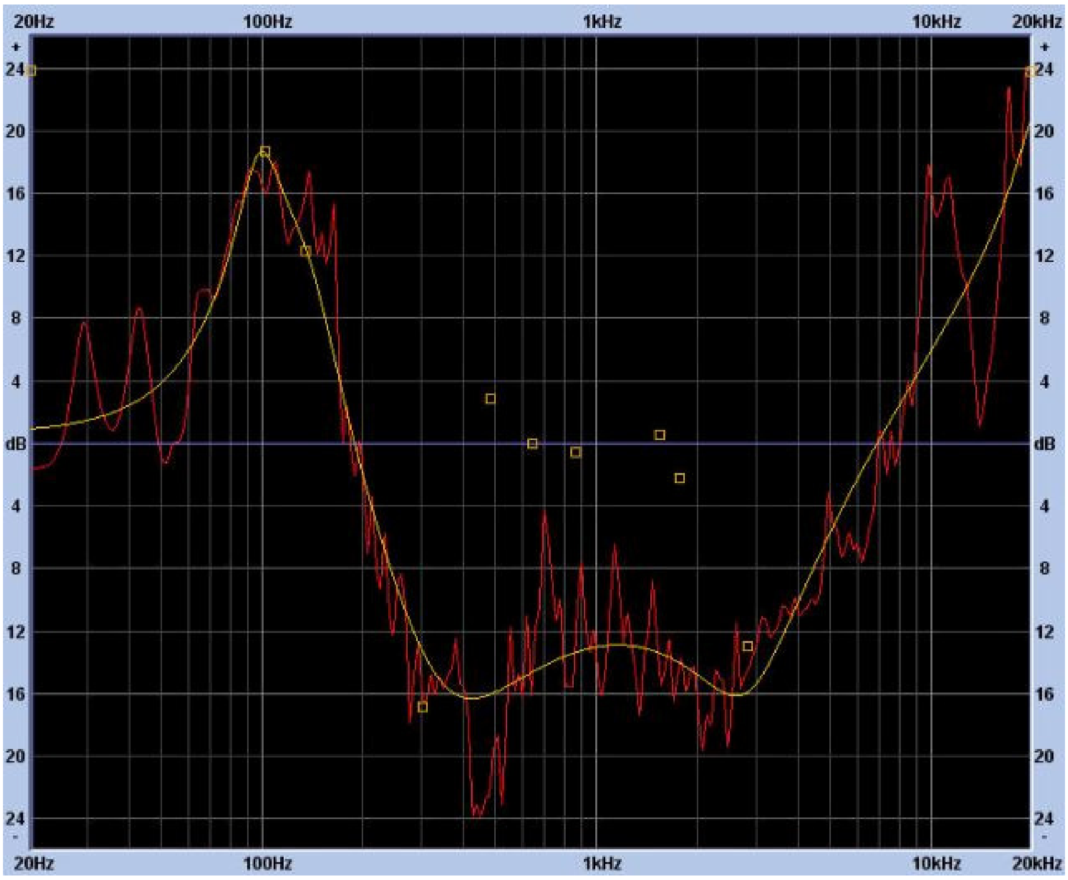

Fig. 3 Use of 5 bi-quads produces this curve within a few seconds

A series of videos illustrating the operational aspects of *MajEq* are available under NDA.

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APPENDIX A

Selected Oxford Digital Technical Papers

1. P. Eastty, "Digital Audio Processing on a Tiny Scale: Hardware and Software for Personal Devices", Paper Number 7207, AES 123rd Convention, New York, October 2007.
2. N. Bentall, P. Eastty and D. Stott, "An Efficient, Low-Noise Filter Architecture for Bass Processing on a DSP Core". Paper Number 7351, AES 124th Convention, Amsterdam, May 2008.
3. N. Bentall, P. Eastty and D. Stott, "Tiny DSP: DSP Core, Algorithm Development and 'Device Mastering'". Paper Number 6 AES 34th International Conference: New Trends in Audio for Mobile and Handheld Devices, Jeju Island, South Korea, August 2008.
4. P. Eastty, "Accurate IIR Equalisation to an Arbitrary Frequency Response, with Low Delay and Low Noise Real-Time Adjustment", Paper 7639, AES 125th Convention, San Francisco, October 2008.
5. UK Patent Application Publication No: GB 2 458 631 A, "Improving audio equalisation and filtering to address problems of disruptive phase response in graphic equalizers".
6. International Patent Application Publication No: WO2009/112825, "Improving audio equalisation and filtering to address problems of disruptive phase response in graphic equalizers".
7. UK Patent Application No: 0922702.6, "Determining a configuration for an audio processing operation".