

MULTI-CHANNEL SYSTEMS FOR MEASUREMENT AND CALIBRATION

Dr M Youngman (1), Mr A Bennetts (1), Mr C W Skingle (1)

(1) LMS UK Limited, Cheddar Industrial Park, Wedmore Road, Cheddar.

INTRODUCTION

The production of musical instruments such as the violin, guitar and cello has always involved the tuning of the instrument's resonant frequencies. This has been achieved both by the choice and treatment of the materials used and by the distribution of mass of the material in the instrument.

In the reproduction of sound, the same choices have to be made. The systems involved are, however, complex and it is impossible to effectively tune each system by hand. It has therefore been common practice to take advantage of advances in electronic signal processing technology to help in the design of Hi-Fi equipment.

Over the last 15 years, most companies involved in the production of Hi-Fi systems have purchased a single or dual channel Fast Fourier Analyser. This device has enabled considerable insight into the dynamics of both mechanical and electrical components. In the study of mechanical components the use of Modal Analysis, at least to visualise the resonant frequency deformations, is now common. In the last three or so years, the rapidly decreasing cost of computer hardware has put the purchase of multi-channel computer based measuring and analysis systems within the grasp of medium sized companies.

The benefits which may be accrued by using a multi-channel system for standard measurement tasks is significant, in that more can be done per day and the possibility to store, recall and contrast is enhanced. The real benefits are reaped, however, when new and more advanced techniques designed for multi-channel systems are used. The body of this paper discusses a number of techniques which may be appropriate to the Hi-Fi market place.

1. Optimisation Of A Loudspeaker Cabinet's Dynamics By The Use Of Modal Analysis

The panel resonances, sides, back, etc, act as secondary and unwanted sources when excited by the material played through the system. It is "probably" desirable to ensure that each panel has a different set of resonant frequencies. To keep manufacturing costs to a minimum it would be highly undesirable to achieve this by using materials of different types for equally sized panels.

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The aim is therefore, by means of either the constructional detail or by a simple addition, eg by gluing a small mass/damper, to alter the dynamics of the panels.

The measurement campaign proceeds in the following phases:

- i) Measure a pre-production batch of boxes to establish typical performance in terms of panel resonances.
 - (a) Acoustic Intensity to see if a problem exists, ie let sleeping dogs lie or don't fix it if it ain't broke!
 - (b) Provided a Problem Exists:
Complete modal survey of entire box using voice cord excitation and electrodynamic shakers.
 - (c) Check and correlate the two sets of results, they are both useful and will be needed later in the process.
 - (d) Measure stock panels in free/free and edge constrained modes to ascertain if any of the modes measured on the finished box can be easily related to its component behaviour.

Depending on the results of phases a, b, c & d, the subsequent actions will be decided. Results from a real loudspeaker will be presented at Windermere.

2. Subjective Preferences

The ability to evaluate the effect of a change before it is made is very attractive. This is the reason Finite Element Analysis gained rapid acceptance in the 1970's. In general, stress analysis is not crucial to the playing or reproduction of music. The important area is the pleasantness of the sound which is being produced. It is now possible to affect changes to the sound of an instrument or Hi-Fi system without making physical changes. An obvious example of this would be the change in transfer function of a loudspeaker system. It is a simple matter to alter the shape of the system transfer function and then listen to the "new" sound. The subjective judgement of whether the change is for the better or worse is a much more complex area of discussion.

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CONCLUSION

It is, of course, true that both of these applications are far from new. However, it is only in the last two years that the price of hardware has reduced to a point whereby modestly sized companies can afford to think of doing this type of work. To give some level of confidence to engineers working in the music business, it can be stated that in the automotive, defence and aerospace industries the techniques are well established.