Insertion Loss measurements of an acoustical enclosure by using sound power and MLS methods

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Abstract: The Insertion Loss is one of the most appropriate descriptors for the acoustical performance of an enclosure. The IL is conventionally measured by comparing either sound power or space-averaged sound pressure measurements before and after enclosing the sound source. In this paper a comparison is made between a sound power based IL measurement, inside a reverberation room, and a pressure based IL measurement, using the MLS method. Special attention is paid to practical and technical aspects of both methods, such as time consuming, low frequency limit, signal-to-noise ratio, and background noise immunity.

INTRODUCTION

In relation with a R&D project on Active Noise Control, a (0.86 x 0.71 x 0.53) m³ enclosure has been built at the Instituto de Acústica (IA), in order to characterize its acoustical performance, the Insertion Loss (IL) had to be measured. The aim of this work is to compare a classical sound power based IL measurement, inside a reverberation room (1), with a modern one based in the MLS technique (2). Brief features of each method are described in next Section, followed by key results and conclusions.

METHODS

According to Beranek and Ver (1), the sound power based IL is

\[ IL_w = I_{w0} - I_{WE} \]  \hspace{1cm} (1)

where \( I_{w0} \) and \( I_{WE} \) are the sound power radiated by the unenclosed and enclosed source, respectively, as measured in a reverberation room. The measurement procedure is well known, as described in the ISO 3741 Standard.

MLS are sequences of binary integers generated recursively by N-stage shift registers which have the following properties (3):

- have a flat frequency spectrum,
- are exactly repeatable,
- have low crest factor, and
- are immune to background noise.

These properties make the MLS method an attractive one to measure acoustical characteristics of systems in situ.

RESULTS

For the sound power based method, a wideband loudspeaker, located at the center of the reverberation room, was first driven with random noise, amplified through a B&K 2706 power amplifier, and the radiated field was picked up by four B&K 4921 microphones. Then, the same measurements were made with the loudspeaker within the enclosure. Both signals, with the loudspeaker unenclosed and enclosed, were stored in DAT for post-processing with a Sound Analyzer B&K 2131. The second method uses the Virtual Instrument MLSSA to generate Maximum Length Sequences (MLS). Apart from the different acoustic fields generated by each method, MLSSA is able to post-process the data in order to obtain the IL curve. Thus, the MLS method consumes much less time. In the reverberation room, both methods give similar results (Figure 1). Therefore, it is concluded that MLS provides a reliable method to measure IL.
In order to check one of most prominent features of the MLS method, its immunity to background noise, the IL measurement of the enclosure was repeated in a much noisier area (the parking lot of the IA). The IL curve obtained in this measurement is comparable to the one in the reverberation room. More details will be given during the presentation of this paper.

CONCLUSIONS

The sound power based and the MLS methods afford similar results within the reverberation room. Therefore, MLS provides reliable IL results, while consuming much less time. MLS is able to give also reliable results in noisy environments with a reasonable low frequency limit.

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REFERENCES