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USAGE OF REDUCED NUMERICAL MODELS IN THE DESIGN PROCESS OF A SHUNTED PIEZOELECTRIC ISOLATOR

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The design of modern technical systems is highly affected by the increase of performance and by the usage of lightweight methods, while there are higher restrictions and demands on noise and vibration levels. In more and more applications, these contrary requirements cannot be countered by solely passive measures. In this case, systems for active vibration reduction are used under the restriction of the necessity of a power supply [1]. However, by the usage of these systems, a significant improvement of the relationship between weight and power can be achieved, thus gaining an advantage in lightweight structure, such as aircrafts [2], or satellites applications [3].

In between the fields of passive and active vibration reduction, there are semi passive systems. Such systems can increase the performance of passive measures without the need for external actuation power [4]. One approach for a semi passive system is the shunt damping technique associated with piezoelectric materials [5].

Due to the mutual dependency of mechanical and electrical components, the design process of such systems can be challenging.

This paper is focused on the design process of a system for vibration reduction using the shunt damping technique in combination with a vibration isolator for reducing the vibration transmission of a typical aeronautical panel, normally applied in commercial aircrafts. The main objective of this shunted isolator is the reduction of the transmissibility between an outer panel of the aircraft and its interior.

During the design process, reduced numerical models of both, the panel structure and the shunted isolator mount, are used. The numerical models, based on modal superposition, describe the dynamic behaviour of the single components. They are integrated into a system simulation environment [6].

The first step of the design process is an experimental and a numerical analysis of the panel, in which the resonance frequencies and the mode shapes of the basic structure are described and compared. Using the results of the analysis, a state-space description of the plate is set up and included into a system simulation environment. Consequently the isolator, which consists of a piezoelectric bimorph beam, is principally designed. By an analytical description, the isolator beam is automatically optimized to defined goal parameters, which are the first and second resonance frequency as well as a high electromechanical coupling. Using an impedance-admittance simulation approach [7], both the isolator and the shunt can be

described. On base of the simulation environment, the configuration and the performance of the shunt can be investigated and adjusted.
After the hardware realization of the shunted isolator, it is implemented and examined in a test setup. The measurement results of the system in the test setup are compared with the simulation results of the system.
Finally two shunted isolators are placed between the fuselage panel demonstrator and an ideal test mass. Measurement results show the increased vibration reduction effect of the semi passive system in addition to the solely passive isolation mount.

The paper indicates the usefulness of a shunted piezoelectric element in addition to a passive isolation system. Furthermore an effective preliminary design strategy for the layout of shunted piezoelectric isolators is presented and compared to measurement results.

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