Simulation is more than Software®

Minimizing the interaction of electromagnetic fields

Electromagnetic investigations of transducer-based hearing aids

Fig. 1: Hearing aid products of Bernafon for inductive hearing systems.

Task

Hearing instruments containing a transducer allow for an improved listening comfort of hearing impaired people in public places (theaters, churches…). A widely spread technique uses a so-called “telecoil” to pick up an electromagnetic field created by a loop in the ground (hearing loop). A hearing aid itself typically also emits electromagnetic fields. These fields challenge the integration of the telecoil considerably.

Electromagnetic field simulations could bring significant benefits in the design process, namely reduce hardware iterations and provide insights into the physics of the system. The telecoil being the most important part of the simulations, the goal of this study was first to validate the model, then to examine the influence of the battery springs’ shape and the traces of the PCB on the telecoil’s output voltage.

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CADFEM

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Solution

Since the telecoil is made of more than 6000 turns of a less than 30 µm thick copper wire around a ferrite core, it is modeled by means of a stranded conductor. ANSYS Maxwell's Eddy Current (harmonic) solver includes the ability to add an external circuit attached to the coil's terminal to model the capacitive effect and to measure the induced voltage (fig. 2).

The induced voltage is the response to the oscillating external field. This modeling technique has been validated with three different telecoils. The battery springs play an important role regarding the total field seen by the telecoil. Indeed, the springs form a rather large loop compared to the telecoil.

It was shown that the way in which they deform when a battery is inserted changes the field to which is exposed the telecoil. Therefore, the final solution consists in computing their deformation using ANSYS Mechanical and import the result in ANSYS Maxwell to be able to compute the interaction with the telecoil as accurately as possible (fig. 3).

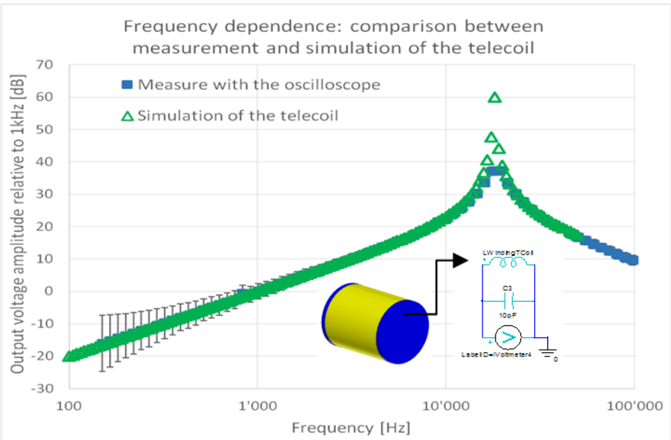

Fig. 2: Comparison of the telecoil's output voltage over frequency between measurement (blue) and simulation (green). Shown are also the telecoil and the circuit connected to it.

Customer Benefit

The project shows that ANSYS Maxwell is a suitable tool for the simulation of electromagnetic fields in hearing instruments or, more generally speaking, for simulating induced stationary currents. There is an excellent agreement between measurements and simulations over a wide frequency range. This also meant the telecoil could be considered as a spatial sensor for local field magnitudes (results not shown here).

Simulations of the telecoil, of the battery springs and the PCB are a new design tool to minimize the interactions between those parts without the need of both in terms of time and ressources costly experiments. In addition, we gained valuable insight into the electromagnetic coupling mechanisms of the apparatus. In the long run, a full simulation of the hearing instrument could be realized, including as well the battery and the receiver.

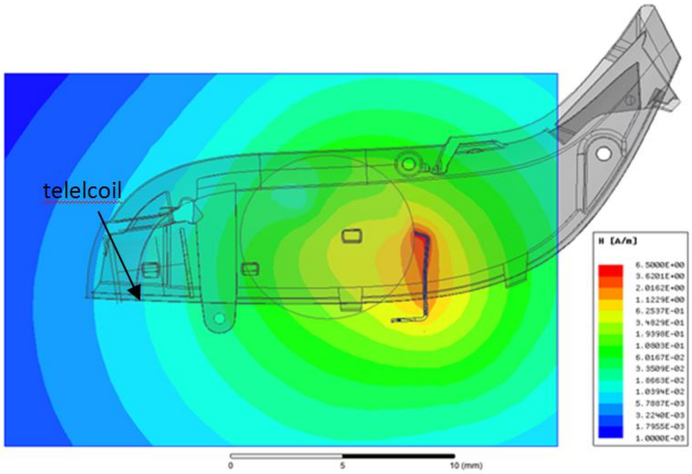

Fig. 3: Magnetic field generated by the current flowing through the springs by taking into account their deformation.

About CADFEM

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