

Impact Of External Permanent Magnets On Balanced Armature Miniaturized Loudspeakers

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Abstract

Balanced armature (BA) receivers are miniaturized loudspeakers used in hearing aid instruments, earphones, and hearables. A typical design of a BA receiver includes an armature (metal strip) that is placed between two permanent magnets and a coil that is wound around the armature. The armature tip is positioned exactly in the center between the magnets and the magnetic fields in the gaps between the armature and the magnets are equal (hence the name, balanced armature) [1]. The current that runs through the coil - representing the audio signal - will inject a magnetic flux into the armature, causing the difference in magnetic field in the two gaps between the armature and magnets. This breaks the magnetic balance and creates magnetic force acting on the armature tip and sets it in motion. A drive pin connected to the armature on one end moves the membrane (diaphragm) on the other end producing sound.

Often in many applications, a BA receiver can get close to a strong external magnet. This can happen, for example, when a hearing instrument or an earbud is placed into the charging case. The charging case can contain magnets to guide the inserted device into position.

In this investigation we then introduced a validated COMSOL model that explains the interference of the magnetic flux due to external magnets with the magnetic flux generated by the BA receiver used to displace the armature. In detail, the static magnetic flux created by the external magnet runs partially via the housing and other internal components of the miniaturized loudspeaker characterized by high magnetic permeability. Further, the simulation results show that the magnetic circuit - that carries the magnetic flux inside a BA receiver - has a profound impact on the receiver frequency response. When an additional magnetic flux is added by the external magnet to the magnetic path inside a receiver, this flux changes the magnetic reluctances [2] of the entire magnetic circuit and causes the receiver magnets to demagnetize. This can lead to irreversible damage to the receiver and, therefore, to a decrease in performance in both low and high frequencies within the audio range or to an increase in total harmonic distortion (THD) [2].

Reference

[1] J. Jensen, Nonlinear Distortion Mechanisms and Efficiency of Balanced-Armature Loudspeakers. Technical University of Denmark, Department of Electrical Engineering, 2014.

[2] W. Klippel, "Nonlinearities in Balanced Armature Transducers," *J. of the Acoustical Soc. of America* 148(1):25- 32, July 2020, DOI: 10.1121/10.0001496

Figures used in the abstract

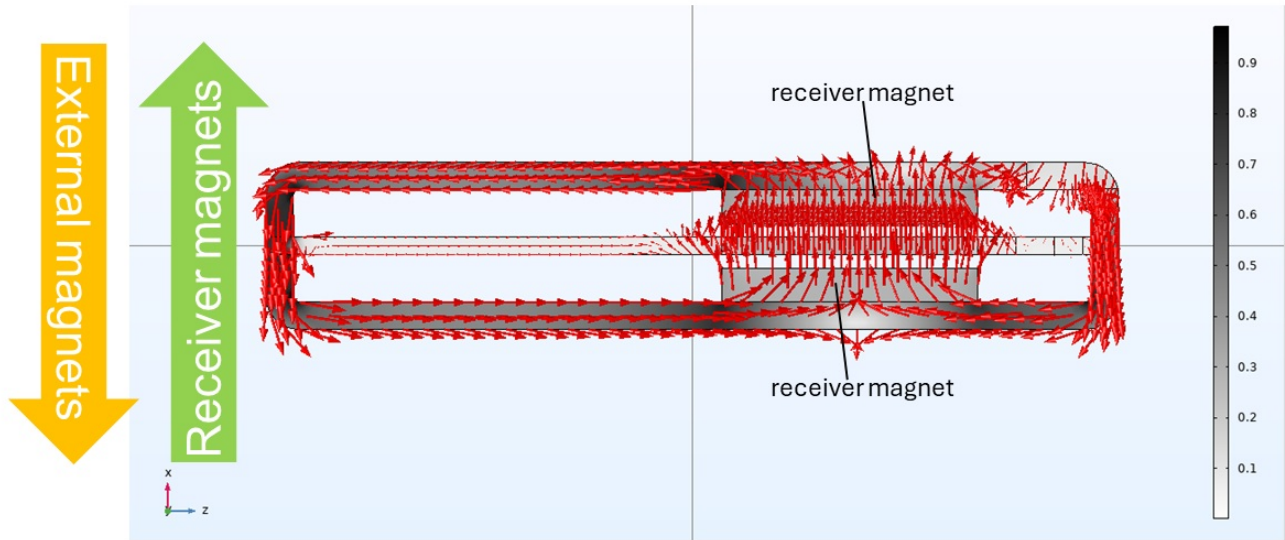


Figure 1 : Both magnetic flux due to receiver magnets and external magnets flow via the receiver case. Magnetic flux density is shown with arrows.