A Field Simulator for Permanent Magnet Applications

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Abstract

Permanent magnets are ubiquitous in our world today, from refrigerator magnets to industrial sensor applications. Often, the magnitude of the field at a specific distance from an arbitrarily shaped magnet of variable strength is a necessary parameter for designing end-use systems. Several online magnetic field calculators exist, but are limited in the geometry and parameters the user can control. We used the "Magnetic Field, No Currents" interface of the AC/DC Module of the COMSOL Multiphysics® software to simulate field strength of permanent magnets for aiding application optimization. We executed various simulations to establish optimal magnet and detector arrangement for maximal/minimal field strength and alignment tolerance. Magnet geometry, remnant flux density, and surrounding material parameters were varied. We conclude that the volume of the magnet and not the geometry dictate the value of maximal magnetic flux density from a magnet edge. We also establish that polarization of the magnet in the short direction results in a higher B-field close to the magnet edge along the axis of polarization. We show that field uniformity is enhanced along the direction of geometrical elongation of a magnet. We also simulate two magnets embedded in a steel disc to determine the size and arrangement that ensure resolvable magnetic peaks (Figure 1). An application of such a construction could be a rotational mechanism that senses position by magnetic field. Finally, we use the Application Builder of the COMSOL® software to design a comprehensive GUI for users to input material, distance, and geometrical parameters to simulate B-field and dispersion along different axes. We are also in the process of employing the COMSOL Server™ as a tool for evaluating rectangular magnets with Hall Effect magnetic field sensors. A screenshot of our tool can be seen in Figure 2.

Figures used in the abstract

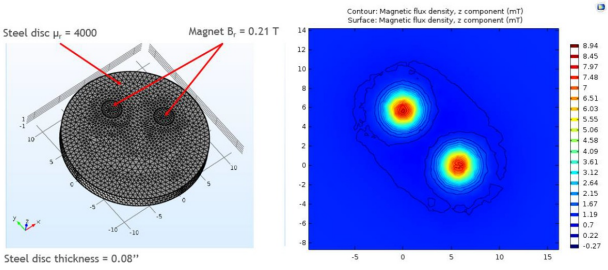

Figure 1: Simulation of two magnets embedded in steel disc (left). Magnetic flux density (right) simulations show resolution of two magnetic peaks.

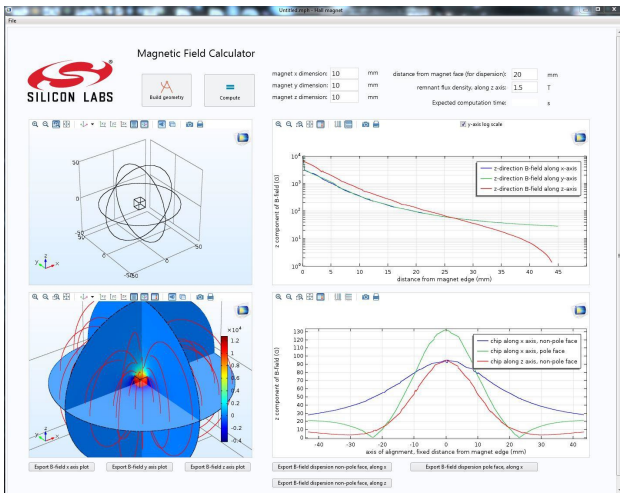

Figure 2: Screenshot of the magnetic field calculator app designed using Comsol Application Builder.