Detachable Acoustic Electric Feedthrough for In Situ SHM Systems

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Abstract
This presentation outlines the development and characterisation of a detachable acoustic electric feedthrough (DAEF) to transfer power and data across a metal (or composite) plate. The DAEF approach is being explored as a potential means of wirelessly powering in-situ structural health monitoring systems embedded within aircraft and other high value engineering assets. The DAEF technique operates via two axially aligned piezoelectric-magnet structures mounted on opposite sides of a plate. Magnetic force is used to align the two piezoelectric-magnet structures, to create an acoustic path across a plate. The piezoelectric-magnet structures consisted of Pz26 piezoelectric disk elements bonded to NdFeB magnets, with a standard ultrasonic couplant (High-Z) used between the magnet and plate to facilitate the passage of ultrasound. Measured impedance curves are matched to modeled curves using the Comsol multi-physics software coupled with a particle-swarm approach, allowing optimised Pz26 material parameters to be found (i.e. stiffness, coupling and permittivity matrices). The optimised Pz26 parameters are then used in an axi-symmetric Comsol model to make predictions about the DAEF power transfer, which is then experimentally confirmed. With an apparent input power of 1 VA and 4.2 MHz drive frequency, the measured power transfer efficiency across a 1.6 mm Al plate is ~34%. The effect of various system parameters on power transfer is explored, including bondline thickness and plate thickness. DAEF data communication is modelled using LTspice with three-port one-dimensional piezoelectric models, indicating that data rates of 115 kBit/s are feasible.