Miniaturised wireless power pickup for a mouse telemeter

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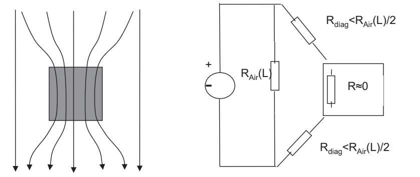
Abstract

Mice are the animal of choice for physiological research because of the large number of disease models available. However, the small size of mice is very challenging when creating a long term implantable telemeter. Here, we present the development of the wireless power pickup for use in a mouse implant

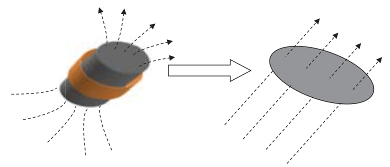
Background

Ferrite is used to increase power pickup through enhancing mutual inductance



Length is required in order for a ferrite to draw in flux from the surrounding region through lower reluctivity

A pickup with a ferrite core effectively has a larger surface area than the same pick up without a core – it looks like a wire loop with a bigger surface area



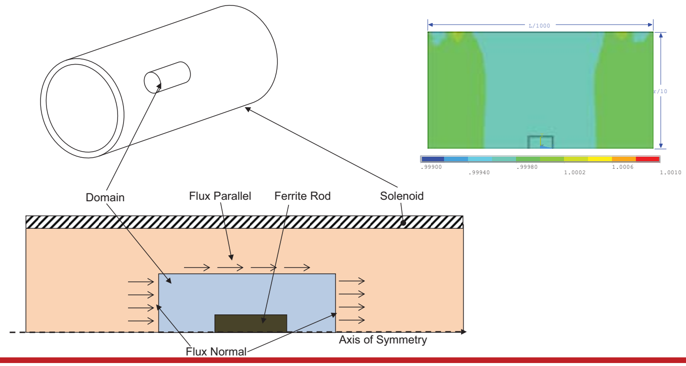
A_e is the equivalent surface area which represents the flux "capturing ability" of a distributed or ferromagnetic pickup. When placed in a constant magnetic field it receives the same flux linkages.

We can characterise this increase using the core effective permeability μ_{core} and the effective area A_e. Further, we can evaluate pick up performance with the figure of merit X_2

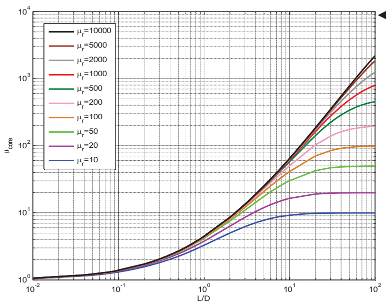
$$\mu_{core} \equiv \frac{A_e}{A_c} \qquad X_2 \equiv \frac{A_e^2}{R_{20}}$$

The Computational Model

A finite element model was developed to efficiently evaluate wireless power pickups used under loosely coupled conditions in ANSYS

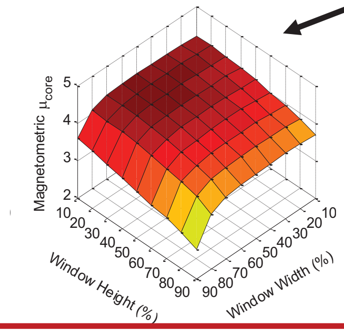


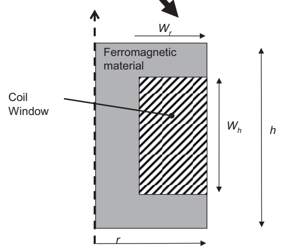
Key Findings



This plot generated from the model shows how much benefit can be derived by adding ferrite to a pickup coil

However, we can derive almost all of the benefit of a core but save a lot of weigh by thinning out the centre section as sown below

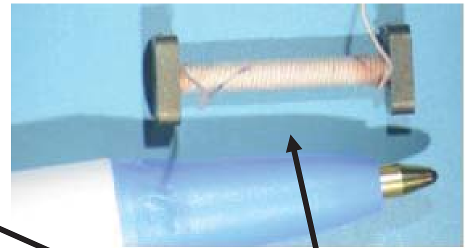




Cross section of a ferrite bobbin core with winding window.

Practical Use

The model was used to design a pickup core for a mouse implant which requires a high degree of optimisation to meet the size, weight and power requirements



Parameter	Current state of the art	New design
A_e (ANSYS)	2.27 x10^{-4}m^2	2.49x10^{-4}m^2
MLT	3.17mm	2mm
R_2 (measured)	0.57 Ω	0.43 Ω
N_2	26	34
X_2	0.6 x10^{-4}m^2/Ω	1.7 x10^{-4}m^2/Ω
Copper weight*	0.67g	0.06g
Core Weight*	1.16g	0.46g
Total Weight*	1.83g	0.52g
Normalised performance per weight	100%	**1250%**

The implant was designed to fold around the core in order to allow the core to be as long as possible which leads to the overall minimum implant size