Department of Electrical Engineering & Computer Science
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Magnetically Coupled Energy and Data Transfer System for Sensors

ABSTRACT - Masterthesis

Magnetically coupled systems can be used to gather information wirelessly and without need of a battery to power the secondary side. These inductively powered wireless transceivers receive power from a time varying magnetic flux and can simultaneously transmit and receive data via the magnetically coupled link. The following thesis examines the magnetic field and circuit theory of a magnetically coupled temperature measurement system operating in the 13.56 MHz ISM, Industrial Scientific Medical, band. It will transmit energy from the primary side to the secondary side to power the temperature sensor and the temperature data will be transmitted back using load modulation and ASK, Amplitude Shift Keying, to the primary side, see Figure i.

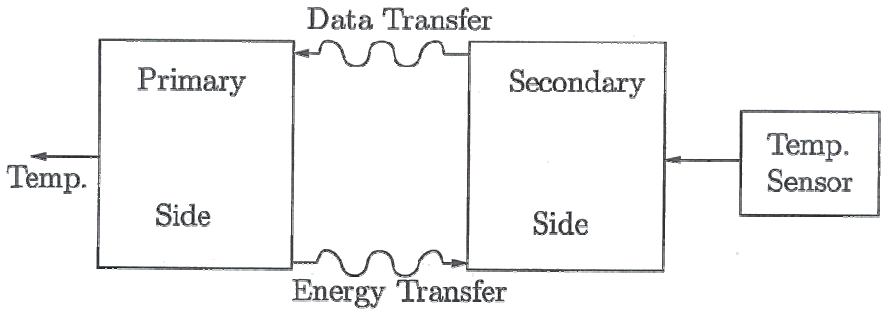

Figure i: Inductively Powered Temperature Measurement System

The intended application for the temperature sensor system is in the drivers cabin in an automobile as part of a climate control system. The primary side reader is embedded in the rear view mirror and the secondary sensor tag is embedded or glued to the front windshield. By monitoring the temperature and humidity on the windshield, the climate controls can be automatically set to defrost when the need arises. As far as known, to date, no such application has been developed in the automotive industry.

Wire contact, in this case, is not desirable due to a number of factors. In a BMW, the average amount of copper wire, connecting over 300 sensors, is approximately 80 km. It is hoped, that a shift to magnetically coupled sensor systems will reduce the amount of wire and thus the amount of weight and therefore lead to an increase in fuel efficiency. Also, such as a temperature measurement against the windshield needs to be wireless to allow for easy windshield replacement. Plus, wire contact is

not as reliable and this could lead to a higher warranty return rate and thus higher costs.

The thesis covers magnetic field theory, based an the Maxwell Equations and leading to Faraday's and Ampere's Law. Next, a general description of the building blocks of magnetically coupled systems follows. Following this is an in depth analysis of the design of the magnetic link including mathematical models, simulations and measurements. Finally, the design and simulation of the electronics are discussed and the system is shown.