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Powering for Long Term Monitoring in the Enclosed Areas

A. Boura, M. Husak

Department of Microelectronics, Faculty of Electrical Engineering
Czech Technical University in Prague
Technicka 2, CZ – 166 27 Prague 6, Czech Republic
Phone/Fax number: +420 224 352 237 / +420 224 310 792, e-mail: **bouraa@fel.cvut.cz**, **husak@fel.cvut.cz**

Abstract. Paper presents possible solution and practical examples for wireless powering and signal transfer using the inductive coupling. It can be suitable for long term monitoring in enclosed areas and systems that are isolated form the surroundings. This solution allows avoiding the batteries. It can be used for probes bricked in to the wall, extreme temperature environment measurement, the barrels internal shells health monitoring etc. Main advantage of this kind of powering is nearly unlimited lifetime, no toxic pollutions (such as Cd, Li, H_2SO_4,… contained in the batteries) and universal applicability.

The powering is provided by the near magnetic field and using the coupled inductances. Equivalent circuit of the coupled inductances can be derived and consequently the resonance behaviour. The resonance is considered in the design for increasing the voltage transfer. The most powerful is simultaneous serial resonance on the input and the parallel resonance on the load.

Potentiality of the powering is given by the distribution of the magnetic field. The field drop is proportional to $1/x^3$ for distances much bigger than the coils diameter and thus also the maximal power is dependent this way. For smaller distances the secondary coil is embracing also the non-axial magnetic field. This is why it is changing faster for the smaller distances. This change is approximately exponential. Character of this dependency is changing approximately at the distance equal to the diameter of the bigger coil.

Also the passive signal transfer can be performed using this principle while it is similar to the RFID systems (Radio Frequency Identification). The voltage transfer in resonance is very sensitive on the loading impedance because it is changing the quality factor of the resonance tank circuit. Also the input current of the primary inductance is changing according the load. This effect can be used for communication between the powered probe and the transmitting device. The signal transfer from the sensing probe can be realized using the current measurement in the primary inductance while the loading resistance is changed by the switch. For each position of the switch it is different also the input current because the modulating resistor R_m changes the quality factor. Loading impedance represented by the sensing probe is stable (or slowly changing) because of the filtering capacitor. Current change on the input is thus caused mainly by the output signal from the probe.

The main contribution of this paper is prediction of the powering potentialities and distance limits of this strategy. Voltage levels, power transfer efficiency and signal modulation effects are studied up to distance of 30 cm. The simple coils are considered.

Special kind of converter was presented. It can be used for measurements in the enclosed systems. Its functionality was performed on example of surface health monitoring. This can be used as a safeguard for barrels containing dangerous pollutions. The output is represented by the rectangular signal with variable pulse ratio so it can be used also for other measurements.