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Resonance Based Wireless Power Transfer System for Actuation of Implantable Piezoelectric Micropump

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Abstract: The diaphragm based actuation pumps are easier to fabricate and design as compared to other actuation method. The conventional way of giving electric supply through wires to piezoelectric crystal will not help the micropump as the better choice in medical field applications. This paper presents the resonance based wireless charging system for piezoelectric implantable micropump.

1. INTRODUCTION

Recent research suggest that the number of people die from cancer can be minimized to one third by adapting proper services and technologies [1]. Most of the treatment involves invasive surgery to remove cancerous cells, followed with radiation or chemotherapy. But when these treatments are used to initiate the cell death the healthy cells are also gets affected and leads to side effects. This could be overcome by delivery of drugs to specific tissues with proper frequency of dosing and amount of drug needed. So the drug delivery system has reached potential solution in healthcare and medical market [2]. The use of MEMS technologies gives a safer and effective delivery of drugs as compared to conventional drug delivery routes like injection or tablets. In recent years, micropump got the much attention in the field of drug delivery, micro total analysis, chemical and biological analysis, space exploration and microelectronics cooling [3]. Based on the actuation principle used micropumps are classified into several types like electromagnetic, electrostatic, magnetohydrodynamic, shape memory alloy, thermopneumatic and piezoelectric. Since the applications demand for the high pressure, high flow rate, simple size and economical designing the micropump with proper actuation mechanism becomes the difficult task [4]. The piezoelectric micropump offers the prominent characteristics like large power density, simple structure and high flow rate [5]. It uses thin plate or disc type piezoelectric crystal for the deformation of diaphragm and to move the fluid from inlet to outlet by creating pressure difference in the chamber. The diaphragm based actuation pumps are easier to fabricate and design as compared to other actuation method [6]. The conventional way of giving electric supply through wires to piezoelectric crystal will not help the micropump as the better choice in medical field applications[7]. Resonance based wireless power transfer could be a better solution for actuation of the crystal and micropump.

2. SYSTEM MODELLING AND DESCRIPTION

The common two coil RWPT system consist of transmitting coil placed outside the human body and receiving coil connected with load circuit and placed inside the human body [8]. The equivalent circuit model describing the RWPT is shown in Figure 1. The transmitting and receiving coil can be considered as series circuit consists of resistance (Rt, Rr), inductance (Lt, Lr) and capacitance (Ct, Cr) and load resistance of Rl.

The mutual inductance between the coil is denoted by M. By applying Kirchhoff's voltage law to this circuit the relationship between current through the coil and voltage across each port of the circuit can be expressed as (1)

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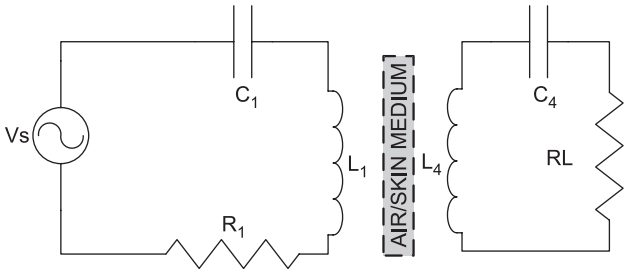


Figure 1: Equivalent Circuit of 2 coil System

3. EXPERIMENTAL ANALYSIS

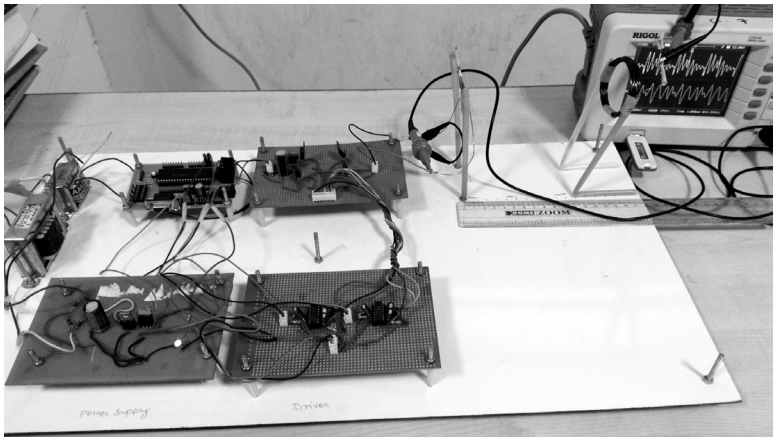
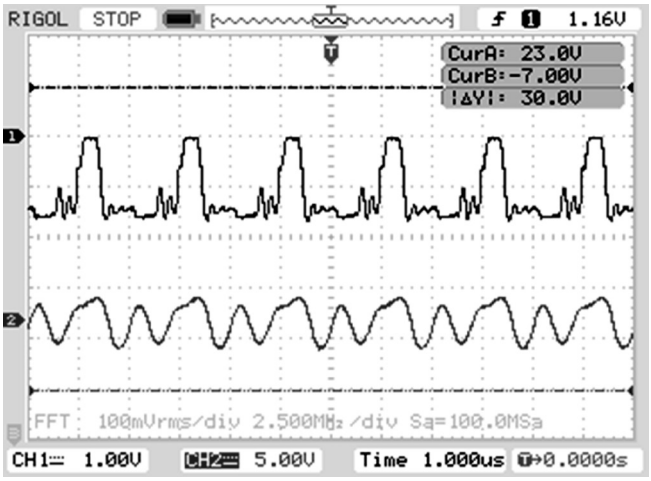


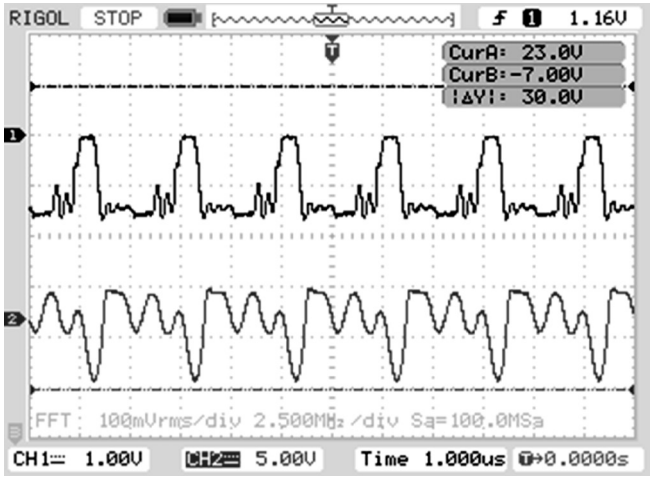
Figure 2: Experimental Setup

In the continuous movement of the receiver loop coils because of the magnetic over coupling frequency splitting occurs. Which degrades the system efficiency also the fluctuation in the output power of the receiver loop. It can be avoided if the mutual inductance between the Tx and Rx coil is almost constant irrespective of the coil separation.

4. CONCLUSION

In this paper the resonance based wireless charging system for piezoelectric implantable micropump. The diaphragm based actuation pumps are easier to fabricate and design as compared to other actuation method. The usual way of supplying electric supply through wires to piezoelectric crystal will not help the micropump as the better choice in medical field applications.





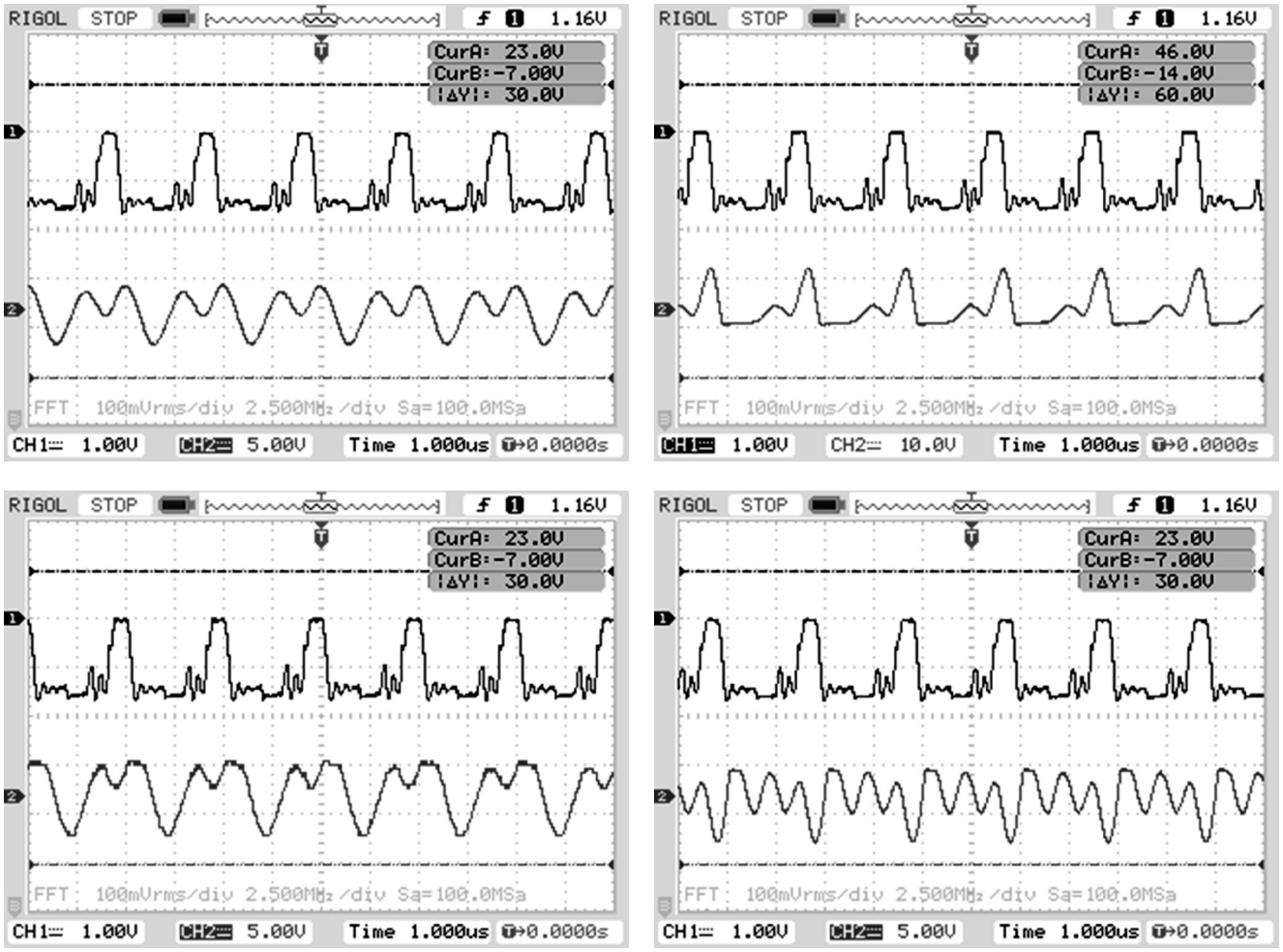


Figure 3: Input and Output Voltage

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