MAGNETIC TORQUE OBTAINED USING FINITE ELEMENT MODELLING OF ELECTROMAGNETIC MICRO RELAY

RESEARCH MANAGEMENT INSTITUTE (RMI)
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BY :

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Contents

2. Letter of Offer (Research Grant)

UNIVERSITI TEKNOLOGI MARA

Surat Kami : 600-RMI/ST/DANA 5/3/Dst (101/2011)
Tarikh : 18 Mei 2011

Encik Azahar Taib
Fakulti Kejuruteraan Elektrik
Universiti Teknologi MARA (Pulau Pinang)
Jalan Permatang Pauh
13500 Permatang Pauh, Pulau Pinang

Y. Brs. Profesor/Tuan/Puan

KELULUSAN PERMOHONAN DANA KECEMERLANGAN 05/2011

Tajuk Projek	:	Magnetic Torque Obtained Using Finite Element Modelling of Electromagnetic Micro Relay
Kod Projek	:	600-RMI/ST/DANA 5/3/Dst (101/2011)
Kategori Projek	:	Kategori F (2011)
Tempoh	:	1 Jun 2011 – 31 Mei 2012 (12 bulan)
Jumlah Peruntukan	:	RM 7,000.00
Ketua Projek	:	Encik Azahar Taib

Dengan hormatnya perkara di atas adalah dirujuk.

2. Sukacita dimaklumkan pihak Universiti telah meluluskan cadangan penyelidikan Y. Brs Profesor/tuan/puan untuk membiayai projek penyelidikan di bawah Dana Kecemerlangan UiTM.

3. Bagi pihak Universiti kami mengucapkan tahniah kepada Y. Brs. Profesor/tuan/puan kerana kejayaan ini dan seterusnya diharapkan berjaya menyiapkan projek ini dengan cemerlang.

4. Peruntukan kewangan akan disalurkan melalui tiga (3) peringkat berdasarkan kepada laporan kemajuan serta kewangan yang mencapai perbelanjaan lebih kurang 50% dari peruntukan yang diterima.

Peringkat Pertama	20%
Peringkat Kedua	40%
Peringkat Ketiga	40%

5. Untuk tujuan mengemaskini, pihak Y. Brs. Profesor/tuan/puan adalah diminta untuk melengkapkan semula kertas cadangan penyelidikan berdasarkan borang penilaian yang dilampirkan, mengisi borang setuju terima projek penyelidikan dan menyusun perancangan semula bajet yang baru seperti yang diluluskan. Sila lihat lampiran bagi tatacara tambahan untuk pengurusan projek.

Sekian, harap maklum.

"SELAMAT MENJALANKAN PENYELIDIKAN DENGAN JAYANYA"

Yang benar

MUSTAFAR KAMAL HAMZAH
Ketua Penyelidikan (Sains dan Teknologi)
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5.2 Enhanced Executive Summary

Micro Electromechanical Systems (MEMS) is an area of research and applications that is becoming increasingly popular. One of MEMS device that is becoming increasingly important in a wide range of industries such as the computer industry, the medical industry and the automotive industry is micro relay. Generally, there are three types of micro relay based on actuation methods; electrostatic, electrothermal and electromagnetic. This research project focuses on electromagnetic micro relay. The need to study the magnetic behavior of electromagnetic micro relay is due to ongoing demand in area of micro relay design and fabrication. This study will focus on analyzing the magnetic behaviors of a specific electromagnetic micro relay. It involves the analytical and finite element modeling. The results from these two analyses are compared in order to verify the reliability of results obtained. Prior to the validation, a complete model of micro relay is developed using finite element modeling via ANSYS software. Investigations on magnetic behaviors of the electromagnetic micro relay are performed via Finite Element Analyses. By varying the current density on the EM planar coil on the micro relay structure, the operating principle of electromagnetic micro relay can be simulated and observed. In addition, it also includes the investigation of magnetic torque upon the armature of the micro relay when certain parameters are varied. The parameters are the thickness of the armature, air gap between the permanent magnet and EM planar coil, and the amount of current density applied to EM planar coils. The effect of the parameter's variation are presented and discussed. These results provide a good insight of the magnetic behavior of the investigated electromagnetic micro relay which will be very useful in designing an electromagnetic micro relay.

5.3 Introduction

Most commercial applications such as instrumentation and communication require electromagnetic relays which can operate in the range of up to one ampere. Thus, a miniature electromagnetic relay or electromagnetic micro relay was born. The emergence of Micro Electro Mechanical System (MEMS) technology has opened up new era that aid the development of micro relays. Various manufacturing technique was introduced to batch fabricate the micro relay. One of the most recent development was electromagnetic bi-stable micro actuator fabricated on a single wafer [1]. This new technology advantages are in low power consumption and large displacement of the actuator. Before any micro relay is batch fabricated, a design process involving a Finite Element Analysis is needed in order to investigate the influence of physical size, magnetic strength, flux density and torque towards micro relays performance.

Traditionally, electromagnetic relays have been fabricated from a number of discrete components which include an armature made of soft magnetic material, elastic spring, electromagnetic coil, a magnetic core, and special metal contacts. For applications that require relatively long periods of time for the switch to remain in open or closed position, a permanent magnet is introduced into the circuit to maintain the switch in closed or opened position with or without the control signal operation. One of the latest development is a micro relay that repeatedly switching over a gap length of 100 μm has been designed specifically for RF application [2].

The implementation of magnetic actuation schemes at the micro scale is quite challenging. Even more challenging is to study how the micro relay reacts to certain changes. These changes may include current density applied to electromagnetic coils, air gap between the magnetic core and the electromagnetic coils, and physical size of components associated with the micro relay. These changes may influence the magnetic torque, force and field strength upon the armature. Magnetic torque determines the motions micro relay's cantilever, while force and field strength contributes to magnetic effect of latching or holding the armature in open or close position.

Finite Element Analysis (FEA) is a powerful computational technique for approximate solutions to a various engineering problems with complex domains subjected to general boundary conditions [3]. FEA has become an essential step in the design or modeling of physical entities in various engineering disciplines. A physical entity usually occurs in common materials (solid, liquid or gas) and involves several field variables. The field variables vary from point to point, thus possessing an infinite number of solutions in that specific domain.