

## **CHAPTER 1**

### **INTRODUCTION**

Micro Electro Mechanical System (MEMS) microrelay was proposed as case study in this final year project of Bachelor Engineering in University Malaysia Perlis (UniMAP) as the partial fulfillment of the requirements. This project concerns about design, modeling and simulations of a piezoelectric microrelay with a signal path for applications in telecommunication. It is aided with some Computer Aided Design (CAD) software such as MEMS Pro in modeling, and SAMCef Field and Oofelie in simulations.

#### **1.1 Introduction to MEMS Microrelay**

There have been significant recent interests in applying MEMS technology in miniaturization of electromechanical relays for variety of applications in the telecommunication, test equipments, and automotive fields. Mechanical switches with metal-to-metal contact are still preferred where low insertion loss and high off-isolation are required, particularly in cost sensitive applications. MEMS technology offers great promises in addressing the need for smaller device, and may bridge the performance and economic gaps between conventional electromechanical technology and solid state devices. Therefore it's continue to be the device of choice in application where are required low on-resistance, high off-isolation and low power consumption in modest cost [1].

Basically, microrelay is a four terminal device [2] where two of the terminals are used for actuation and other two are switched. This mode is equivalent to a conventional

electromagnetic relay and hereafter will be referred to as a microrelay [3]. It is differed compare to switches which generally will only have three terminals as source and drain with a gate to close or open the connection between them. Furthermore, the actuator of microrelay is separated from the contactor by an insulting layer and hence the electrical isolation between the contactor and the actuator beam that mechanically connects the contactor to the beam while maintaining electrical isolation. Since, microrelays have the advantages of integration of micro structure with other electronic devices on single die and offering better promises, therefore it have the potential to replace the conventional relays and traditional solid state devices in significant market with it's vast opportunity for ingenuity.

## 1.2 Problems Statement

This project was carried out in technology push mode [4] which means that it is focusing on the development and the refinement of the general underlying technique for unspecified or broadly defined applications. MEMS is a technology embodies concepts from both electrical and mechanical engineering domains and also employs the microfabrication technology, which is fast evolving discipline. So that, principle science and multiple engineering disciplines are involved in MEMS design and manufacture [5] in order to successfully design and development later. Therefore, a virtue prototyping was modeled by using both numerical method and CAD modeling before fabrication in cleanroom for simulations with Finite Elements Analyses (FEA) method afterward.

By the way, there are several important challenges must be met at the outset to design a device suitable to the real world [1]. Firstly, electromechanical microrelay must have switch gaps capable of withstanding reasonable load voltages or giving high off-isolation. Secondly is to make a MEMS microrelay lies in achieving sufficient contact force to obtain low and stable contact resistance (on-resistance). Other than that, it must also design to have the ability to withstand current surge effects in order to reach longer life time in applications.

### 1.3 Objectives

Several objectives had been set as a target to be achieved in this project which is named as MEMS Microrelay: Design, Modeling and simulation. According to the title, a MEMS microrelay must be designed and model before simulation with CAD in FEA methods. Meaning that, the first objective is to design a microrelay base on piezoelectric actuation method in MEMS technologies. After that, a virtue prototyping is modeled for simulation and analysis with the existing CAD tools at MEMS Design Laboratory of University Malaysia Perlis. The last aim is set to seek for any possible optimization method to improve the performance of the design or suit to the potential application requirement as the solution to overcome the deficiency of the existing relays.

### 1.4 Scope of Study

- Device design, analysis, modeling, simulation and optimization of actuator path.
- Device possible applications.

### 1.5 Report Layout

Chapter 1 briefly describes the background of the final year project and the device to be created. Typically, the microrelay comprises of 3 main elements: a piezoelectricity mechanism actuator, contact bar and the signal path. Further details of microrelay will be presented in following chapter as literatures review in chapter 2. Then, details in design and modeling methodologies of the device will be described in chapter 3. Some other related consideration analysis will also be presented within the same chapter. The results and discussions are presented in chapter 4. The last chapter is to summarize and concludes this final year project. Recommendation for future project and potential commercialization of this device are also included under a same chapter. In appendices, some others related information to this project are also attached together for reference.