UNIVERSITI TEKNIKAL MALAYSIA MELAKA

COMPARISON STUDY ON THE EFFECT OF DOUBLE POGO PIN AND SINGLE POGO PIN IN THE IC PACKAGE PRODUCTION

This report is submitted in accordance with requirement of Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Design) (Hons.)

by

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ABSTRACT

In the IC package production, there are some problems that might be occurred when a type of pogo pin is used. One of the problem is to identify the failure possibility due to internal stress produced in the IC package during the contact of the pogo pin in the production line. The contact might triggered the failure condition on IC package and the respond is different for both applications of single and double pogo pin. The problems was solved by using Finite Element Analysis by evaluating the effect of the single pogo pin and double pogo pin towards the defects on the contact point of IC package. There are three types of boundary conditions that have been considered in this study. The first condition has the support (the ring shape) on top of the IC package. Then, the support for the second condition at two shorter edges of the top IC package while for third condition, the support is on the entire top IC package. The results of the analysis for the both application have been compared. The use of the double pogo pin has been found to be better choice in order to avoid failure effect when compared with the single pogo pin. The stress distribution for double pogo pin is not reaching the plastic deformation. In contrast, for the single pogo pin, the maximum distribution stress is beyond the yield stress. The model and boundary condition for the single pogo pin have been validated and confirmed by the physical test on a certain scope of condition.

ABSTRAK

Dalam pengeluaran pakej IC, terdapat beberapa masalah yang mungkin berlaku apabila sejenis pogo pin digunakan. Salah satu daripada masalah ini ialah menentukan keadaan kemungkinan kegagalan akibat tekanan dalaman yang dihasilkan dalam pakej IC semasa hubungan pogo pin dalam barisan pengeluaran. kenalan yang mungkin mencetuskan keadaan kegagalan pada pakej IC dan tindak balas adalah berbeza untuk kedua-dua tindak balas. Masalah ini dapat diselesaikan dengan menggunakan Finite Element Analysis untuk menilai kesan pogo pin tunggal dan pogo pin dua arah ketidakstabilan pada titik hubungan pakej IC. Terdapat tiga jenis keadaan sempadan yang telah dipertimbangkan dalam kajian ini. Ia merupakan sokongan atau kekangan untuk syarat pertama iaitu adalah bentuk cincin di bahagian atas pakej. Kemudian, sokongan untuk syarat kedua adalah jarak dua tepi lebih pendek pada pakej atas manakala bagi keadaan ketiga, sokongan adalah pakej keseluruhan bahagian. Keputusan analisis bagi permohonan kedua-dua telah dibandingkan. Penggunaan pogo pin berganda telah didapati menjadi pilihan yang lebih baik untuk mengelakkan kesan kegagalan berbanding pogo pin tunggal. Agihan tegasan untuk pogo pin dua tidak kena ubah bentuk plastik. Sebaliknya, untuk pogo pin tunggal (bentuk lingkaran), tekanan pengedaran maksimum adalah di luar lingkungan kawasan. Model dan keadaan sempadan untuk pogo pin tunggal telah disahkan dan dipastikan fungsinya oleh ujian fizikal pada skop tertentu keadaan.

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Table of Contents

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LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

In this chapter, the introduction, background of study, problems statement, objectives, scope for the study and also project schedule is presented.

1.1 Background of study

Integrated circuit(IC) package is one of the device that is used widely in the industrial company related with the electrical and electronic in order to be applied in any applications such as watches, cameras, battery charger, and many more. The electrical and electronics industry leads in Malaysia's sector in manufacturing sector which contributed to the country exports about 32.8 percent in 2013. Besides, it gives the benefits to the global especially in the usage of mobile devices such as smartphone or tablets, storage devices like computing system and so on. Based on the Energy Commission of Malaysia, the primary source of power is important in the industrial sector which is about 45% in 2012. (Energy Resources Conservation and Development Commission, 2012)

Nowadays, the consumer electronic applications show that mostly the users that used the electrical and electronic devices will change or used the devices in a short time. This is because of the problem with the crack or damaged of the IC package during the production. From this problem, there are connections between the pogo pin and also the IC package production which is to identify which pogo pin is better and also to identify

the impact of the force that is applied. Therefore, the comparison study on the effect of the double pogo pin and single pogo pin in the IC package production will be investigated in this project.

1.2 Problems statement

There is a significant problem that might be apprehensive in the semiconductor assembly which is the problem that related with pogo pin application. The problem is when a single pogo pin is used in the production line, there is a dented area spotted on diepad. In contrast, the use of double pogo pin is considered to be safe. However, the assumption might having some problems when not aware with others specific conditions. The problems may come from the different conditions, foreign material, excessive load and also the tail condition on IC package.

1.3 Objectives

To solve the above mentioned problems, this study is conducted to achieve the following objectives:

1. To compare the effect of a single pogo pin and a double pogo pin on the applications of IC package production.
2. To perform the finite element simulation of the static analysis and investigate the internal stress of the IC package.
3. To investigate the influence of the pogo pin applications towards the IC package cracks issue through the static analysis.

1.4 Scope of study

In the static analysis, the results of the comparison between the single pogo pin and double pogo pin will be analysed. The IC package consists of a few part which are mould, diepad, die, adhesive and also wirebounds but the part of wirebounds is not consider as a part because it is not having significant impact for this analysis. Therefore the focus on the study is only on the diepad part through the static analysis of finite element simulation.

CHAPTER 2

LITERATURE REVIEW

This chapter provides a literature review on the part of pogo pin and the integrated circuit package. In addition, a review of the applications in the IC package is explained. Finally, literature about the finite element analysis is explained. This chapter begins with a review on the part of pogo pin and the integrated circuit package.

2.1 Pogo Pin Structure

Pogo pin is one of the tool to identify the impact of the load that is exerted on the surface of the die which is as contacting elements between the device and DUT board (Therese Souza, 2004) .Pogo pin is also one of the device that is used in the automated test equipment (ETA) system which is to show an electrical connection between the semiconductor package and the printed circuit board. The pogo pin usually has a form empty cylinder that contained a spring and the two plungers. They are usually arranged in a dense 2- dimension array that connects together a number of electrical contacts in the test socket. The pogo pins should be designed to allow high obedience transmission and high reliability across the repetitive signals of the electrical signals. The pogo pins properties of the signal transmission are too critical for the test systems to operate at the multi-gigabit data rate (Kim, July 2013).The pogo pin must do a good and able to be trusted for the electrical contact with its body and is compared by using whether single or double pogo pin is suitable on it.

Pogo pin is one of the special type of the contact technology as it can called as the connector as explained in the above statement. The type of connection is the magnetic connection and it contained three parts which are the plunger, spring and last but not least the barrel.

Figure 1: The basic structure of the pogo pin (Davis, L. (2012)

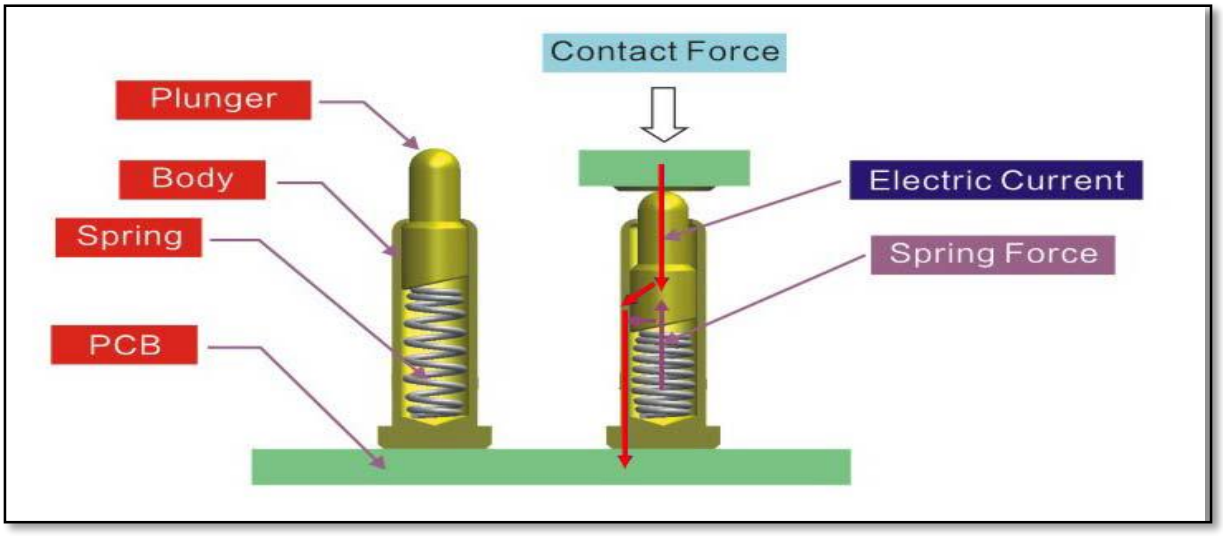
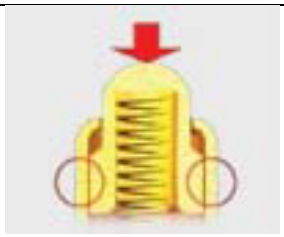
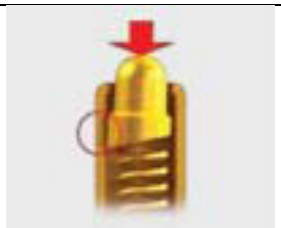


Figure 2: The flow of the electric current (Davis, L. (2012)

2.1.1 Type of plunger structures of pogo pin

There are two types of plunger structures which are Back-Drill Design and the Bias Design. For the tiniest pogo pin connector, back- drill design is the best selection. This is because the length of the spring on the back- drill design is longer than the depth of the barrel and when the force is applied it can reach the part which is the customer wants. The second type of plunger structure is biased design which is it can bring the low interconnection resistance where the interconnection between the pogo pin and an area of the IC package production is decreasing. Since making the plunger is able to contact with the edge of the barrel with 100%, therefore the end of the plunger is sliced like a bias style. Then it is also controlled the absolute of the consistency of the external contact- resistance.

Table 1: Type of plunger structures (Davis, L. (2012)

Type of plunger structures	**Explanations**
 Back-drill design	• It is hollow to save the space for the extension of the spring • It is also for the super-thin mobile device
 Bias design	• The degree of the slope is 12 or 18 degrees • The plunger is able to fully contact with the barrel

2.1.2 Type of material used of each part

Table 2 shows about the material used for each part of pogo pin. This shows that each of the part is made up from different type of materials.

Table 2: Type of material in each part of pogo pin

Part of pogo pin	Materials
Plunger	• Brass • Beryllium copper • Phosphor bronze • Tool steel
Spring	• Stainless steel • Music wire with gold plated • Beryllium copper
Barrel	• Brass • Beryllium copper • Phosphor bronze

2.2 Integrated Circuit (IC) Package

2.2.1 Definitions of the IC Package

Integrated circuit (IC) is a small electrical circuit which consists of an assembly of thousands of electronic components. The IC is also well known as a chip on die which is produce in front-end production of semiconductor industry. Integrating circuits are put into the protective packages. At the same time, the devices are protected from the risk of damage. The last process of the IC packaging is testing, scanning and packaging. The device will be shipped to the customers after completed all the processes.

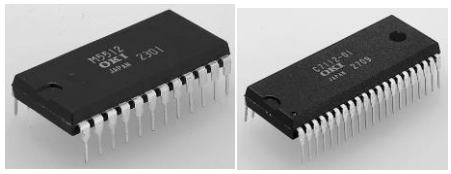
2.2.2 Type of IC Package

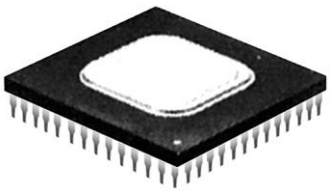
There are some of the type of IC package which are through-hole, surface mount, chip carrier, pin grid arrays, flat packages, small outline packages, chip-scale packages, ball grid array, transistor and small pin count IC packages, and last but not least multi-chip packages. Each of it has difference functions and difference materials that are used in.

2.2.3 Package Type and Its Classification

2.2.3.1 Through- Hole Mounting Type

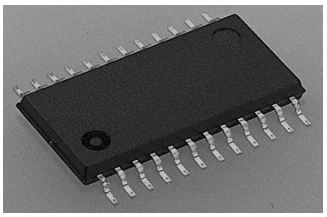
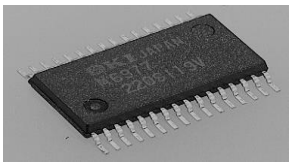
Table 3: Type of Through-Hole Mounting (Davis, L. (2012)

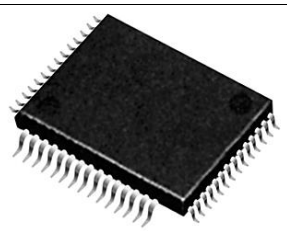
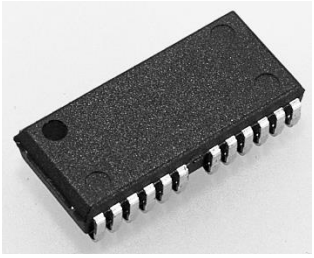
Types	Package Types		
	Classification	**Examples**	
(1)Through – hole mounting type	(1.1) Plastic	Dual In-line (DIP)	 Standard shrink  Skinny

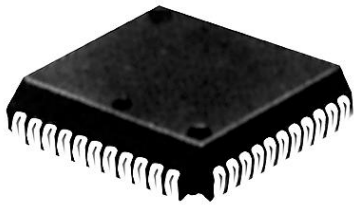
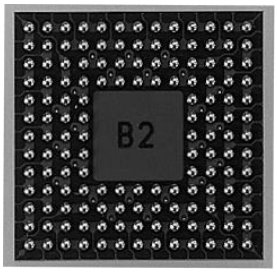
		Zigzag in-line (ZIP) 	
	Ceramic	Standard DIP	
		Glass sealed ceramic DIP(CER-DIP)	
		Pin grid array (PGA)	

2.2.3.2 Surface Mount Type Package

Table 4: Type of Surface Mount Package (Davis, L. (2012)

Types	Package Types		
	Classification	**Examples**	
Surface mounting type package	Plastic	Small outline package (SOP)	
		Shrink small-outline package (SSOP)	
		Thin small-outline package 1 (TSOP 1)	
		Thin, small-outline package 2 (TSOP 2)	

		Quad flat package (QFP)	
		High heat dissipation QFP	
		Thin quad flat pack (TQFP)	
		Low-profile quad flat pack (LQFP)	
		Small outline J-leaded (SOJ)	

		Quad flat J-leaded (plastic leaded chip carrier) QFJ(PLCC)	
		Ball grid array/fine pitch ball grid array (BGA/FBGA)	

2.2.4 IC package category

The IC package category is categorized in three categorized which are dual in-line package, chip corners, and also grid arrays. The dual in-line package is a package with the two rows of leads on the two sides of the package. There are two types of dual in-line package which are through-hole (PDIP OR CERDIP) and another one is an SMT package (SOJ OR SOIC) which is the surface mount technology. While for the chip corners are called as quad flat packs is a square package with leads on all four sides. Lastly the grid array which has the pins that are arranged in the grid and the pin grid consists of three parts which are the leads, pads and also solder balls.

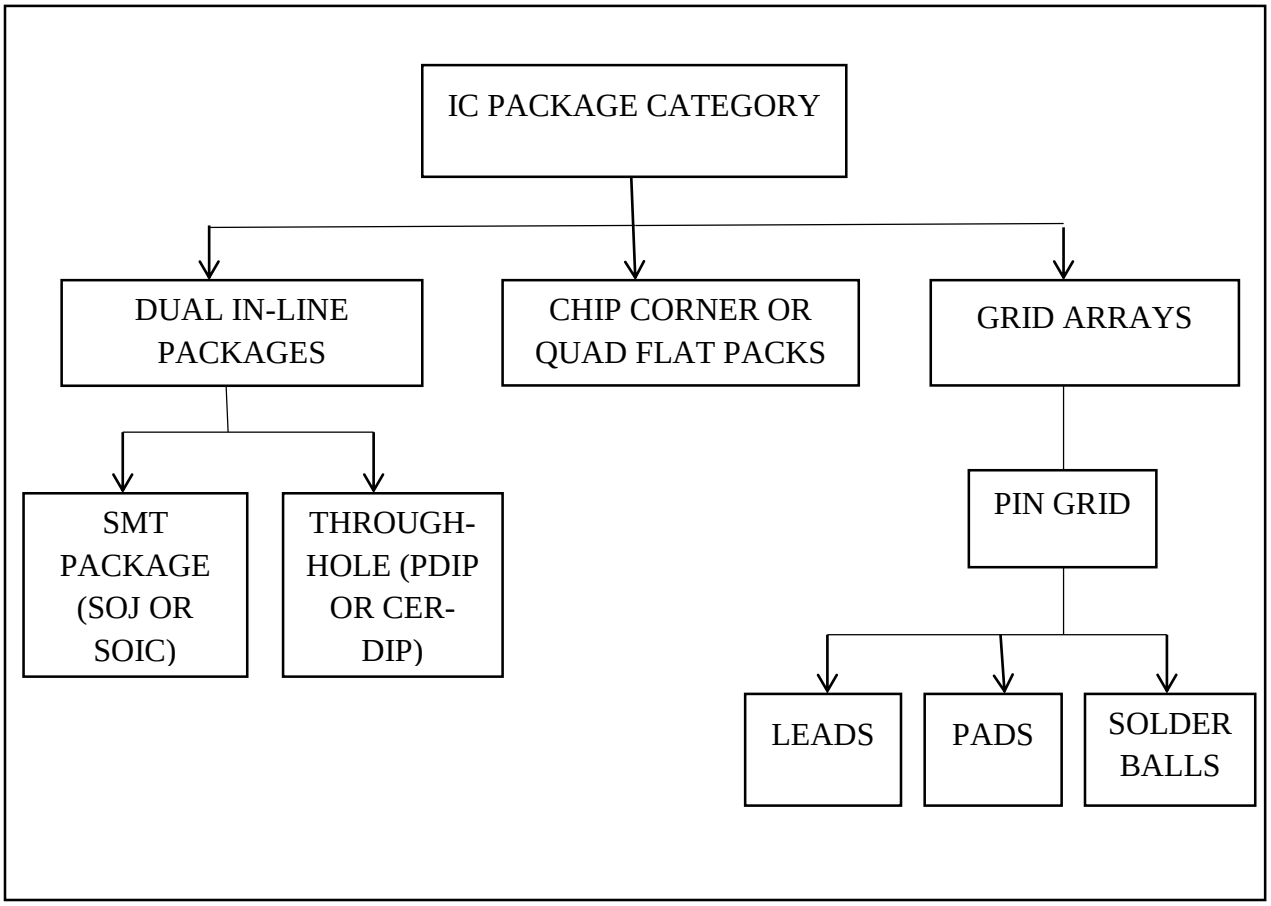


Figure 3: IC package category

Table 4: Category of IC packages (Davis, L. (2012)

Category Of IC Packages		Descriptions
Dual in-line package (DIP)		• First generation IC package type • Is a thru-hole device with the lead with the space of 0.100 “ • Mostly translate to the SOIC packages for higher density applications • The body shape is rectangular
Quad flat pack (QFP)		• High density • The body shape is square and rectangular • The size of the body is about from 7mm to 40mm
Grid array		• Second generation of the IC package type • Thru-hole also but the size of packages is reduced since the pin is moved to the underside of the package in a grid pattern • The shape of the body is square

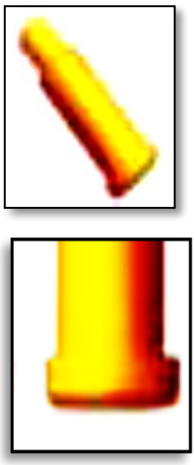
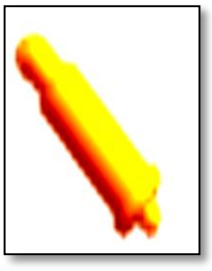
Small outline J-Leaded(SOJ)		• The lead pitch is decreased to 50 mil • Lead looks like the ‘j’ letter which sometimes called J-leaded • The body shape is rectangular
Small outline IC(SOIC)		• First surface mount package • Also called as the Gull Wing • Mostly popular in the memory type of IC for the higher pin count

2.3 Applications on the IC Package

2.3.1 Type of pogo pin

Table 5 below shows the type of the pogo pin. There are some type of the pogo pin which are flat type, plug-in type, right-angle type, multiple types, bending type, double-ended pin and special spec type.

Table 5: Type of pogo pin (Davis, L. (2012)

Types		Explanations
	Flat	• The quality is stable • It is easy to be mounted
	Plug-in	• It is hard to shift after mounting on the PCB • When positioning, it has a good performance