Defect Study of PCBA at Manufacturing Company

by

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Mechanical Engineering Programme
Universiti Teknologi PETRONAS
In partial fulfillment of the requirement for the
BACHELOR OF ENGINEERING (Hons)
(MECHANICAL ENGINEERING)

Approved by,

____
(Kamal Ariff Zainal Abidin)

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH PERAK
May 2011

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

(HABIBAH BINTI HARUN)

ABSTRACT

This report basically presents the research that had been done so far based on this chosen topic, which is **Defect Study of PCBA at Manufacturing Company**. A study of the defect has been undertaken as part of the design and construction of a Knowledge-based System (KBS). The KBS will be required to contribute to a quality improvement in the manufacture of Printed Circuit Board Assemblies (PCBA) and in particular the defect level of the soldering process at manufacturing facility. The defects that often occur during manufacturing the PCBA is **solder bridging**. The project has involved the formal study of solder bridging during the manufacture of highly complex and sophisticated PCBA. The study methods used have included academic research, carefully designed experiments by Celestica engineers, observations of the manufacturing processes and interviews with a wide range of Celestica personnel. A process model has been developed to adopt a high level approach to the problem area and as such embodies the ultimate goals of the proposed system. During the course of the project so far, in addition to the system process model development, part of the PCBA KBS has also been initiated.

ACKNOWLEDGEMENT

First and foremost, thank god for His grace and mercy that He gave to me, without it, maybe I cannot make it through until the end. I would like to extend my most sincere gratitude to the Manufacturing Engineer serve concurrently as my Supervisor, Mrs. Chew Yeat Kim for her full support with continuous encouragement and guidance for me towards completing this project. Besides that, I also want to thank her for monitoring my progress and for helping me to face any problem related to my project. Almost certainly without her cooperation, I might not be able to finish my project, as it needs a lot of commitment towards finishing it.

I would like to express my appreciation to all those who had assisted in making my Final Year Project a success. Especially I would like to thanks my UTP supervisor Mr. Kamal Ariff Zainal Abidin whose help me a lot in completing this project. He was very supportive and assisted me all the time with guides and also advices.

Last but not least, many thanks go to all parties who had also contributed directly and indirectly to the success of my project. Thank you very much, may Allah repays for your kindness.

Thank you,

HABIBAH BINTI HARUN

Mechanical Engineering

Universiti Teknologi PETRONAS

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CHAPTER 1
INTRODUCTION

1.1 Background of study

Celestica is a world leader in the delivery of innovative electronics manufacturing services to OEMs in the information technology and communications industries. They operate over 40 manufacturing and design facilities worldwide, which includes their very own state-of-the-art plant right here in Kulim, Malaysia. Celestica provides a broad range of services including design, prototyping, assembly, testing, product assurance, supply chain management, worldwide distribution and after-sales service [1].

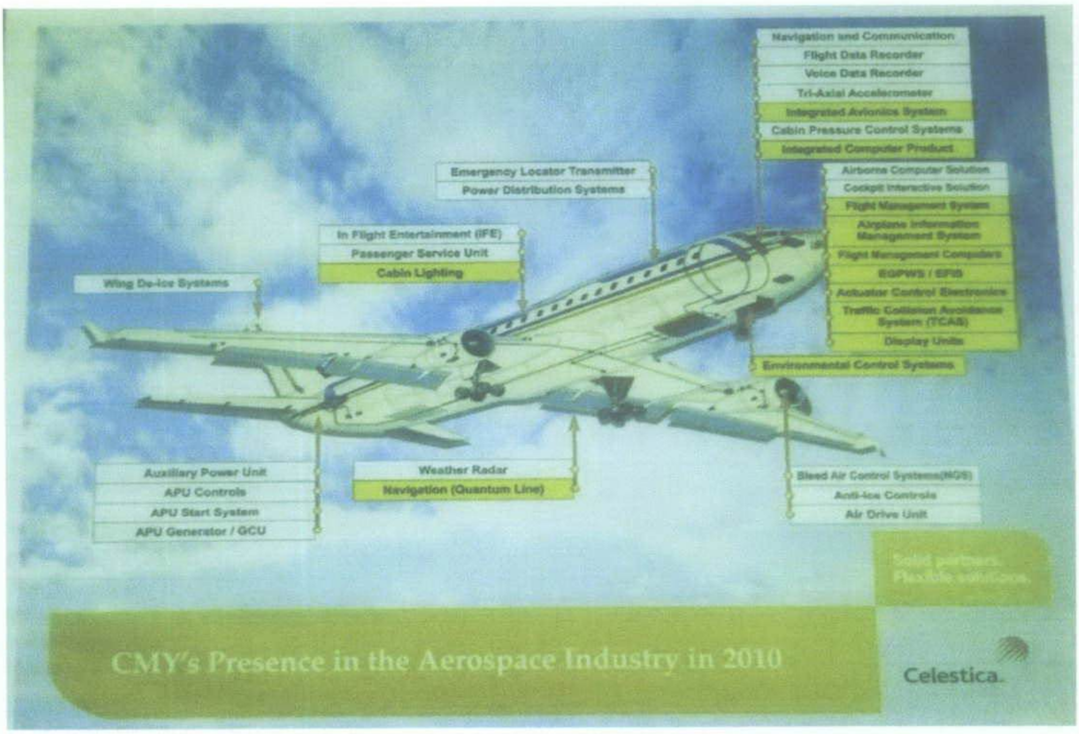


Figure 1: CMY's presence in the aerospace industry in 2010

A defect study is important in order to outline the prioritization of defects under conditions of low sampling statistics based on the deliberate introduction of the defects at specific process points. Simply finding and reducing defects will improve the production of PCBA (Printed Circuit Board Assembly). The defects that detected need to be prioritized by their impact on the parameters, machines and products. The resources are limited including time and personnel; and it is necessary to rapidly determine the defects that have the greatest impact and the location to inspect for yield limiting defects.

The defect which often occurs in the production line is solder bridging. This defect frequently occurs after wave soldering process; where is the process of the components soldered onto printed circuit board. Soldering is the process where two metal surfaces are joined by metallic bonds that created by molten solder between them. Solder joints are supported by the solder when it solidifies and it allows electrical contact between metal in the joints.

1.2 Problem Statement

This company manufactured and assemble aerospace component on PCB (Printed Circuit Board) [1]. There are a lot of component was installed on this PCBA and the method that used is different for Surface Mount Technology (SMT) component and PIN Through Hole (PTH) component. In producing the complete PCBA, there are a lot of defects that encountered and needed to be solved during production. In order to solve the problem, the study of defect is needed in order to find the cause and effect of the defects. In order to do this, there are some consideration that needed to evaluate this defect such as the method using, the material used, the machine involved, the parameters and the equipment used.

The defects that often occur during manufacturing the PCBA is **solder bridging**. The definition of solder bridging is the solder extending between two or more connections that causing short circuits [2].

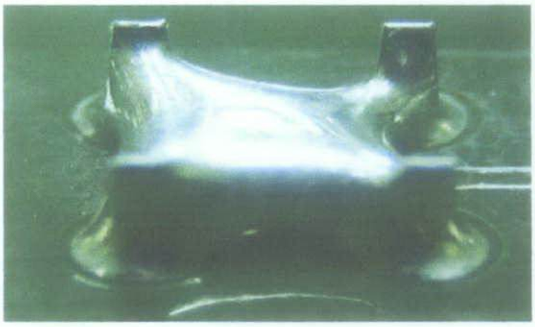


Figure 2: Solder bridging defect

The project involved the formal study of solder bridging during the manufacture of highly complex and sophisticated PCBA. The methods used to investigate this defect have included academic research, experiments designation and observations of the manufacturing processes. Solder bridging occurs after wave soldering process for model C6424, C6423, E12977, E12978, C5571 and C5572.

1.3 Objective and Scope of Study

The objectives of this research are:

1) To study the important factors that leads to solder bridging during manufacture the PCBA.
2) To determine the cause and solution for solder bridging defects.
3) To improve the productions of PCBA by reducing solder bridging defects.

The scope of work for semester one final year project is to research more about the defects known as solder bridging at manufacturing company by designing experiments especially the steps flows of the experiment. Other than that, understands the process parameters as the control factor for the defects. Finally, get familiar with the apparatus or machine.

For the scope of work for the second semester of this final year project is conducting the experiment and evaluation at station that produce the defect. Then the result will be analyzed in order to find the solution. Lastly, the interaction between control factors and noise factor will be determined in finding the optimum parameter value.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction to Process Flow

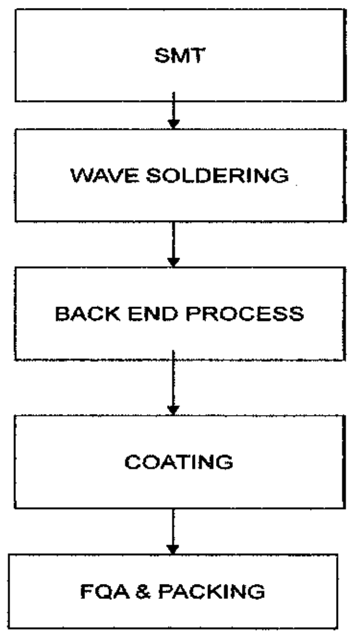


Figure 3: the process flow of manufacturing PCBA

Surface-mount technology (SMT) is a method for constructing electronic circuits in which the components are mounted directly onto the surface of printed circuit boards (PCBs) [1]. Electronic devices so made are called *surface-mount devices* or SMDs. The advantages of SMT process are simpler automated assembly, small errors in component placement are corrected automatically and components can be placed on both sides of the circuit board [1]. In the industry it has largely replaced the through-hole technology construction method of fitting components with wire leads into holes in the circuit board.

Wave Soldering Process is a large scale of soldering process to solder components to PCB especially for pin through-hole (PTH) components [1]. Back end process involved three sub process such as manual solder application, adhesive application (application of araldite, adekit or Silicone CAFF33) and mechanical assembly (Frame Assemble and screwing). Conformal coating is applied to electronic circuits to act as protection for PCBA from moisture, dust, or chemicals. It slightly likes a thin plastic protective layer on PCBA [1].

2.2 Wave soldering process

Wave Soldering is a large-scale process by which electronic components are soldered to a printed circuit board (PCB) to form an electronic assembly [3]. The name is derived from the used waves of molten solder to attach metal components to the PCB. The wave soldering is commonly used for both pin through-hole (PTH) assemblies and surface mount (SMT) [3].

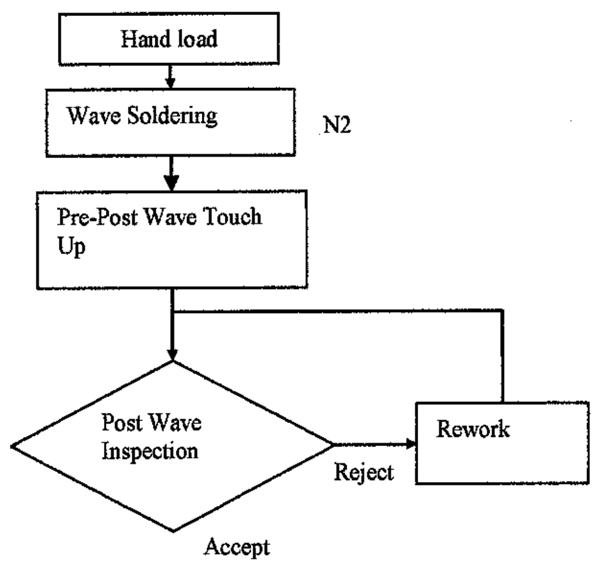


Figure 4: Wave soldering Process flow

There are many types of wave solder machines; however the basic components and principles of these machines are the same. A standard wave solder machine consists of three zones: the preheating zone, the fluxing zone, and the soldering zone. An additional fourth zone, cleaning, is used depending on the type of flux applied. The basic equipment used during the process is a conveyer moves the PCB through those three zones, a pan of solder used in the soldering process, a pump that produces the actual wave, the sprayer for the flux and the preheating pad. The solder is usually a mixture of metals. A typical solder has the chemical makeup of 50% tin, 49.5% lead, and 0.5% antimony [4].

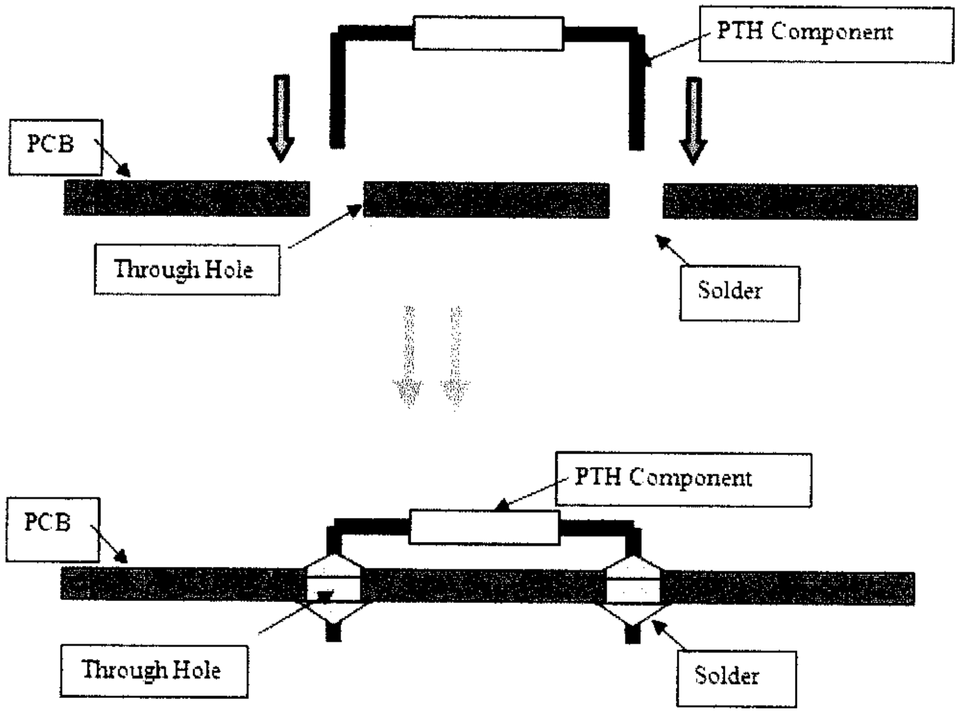


Figure 5: Wave Soldering Process

The concepts and mechanism of wave soldering:

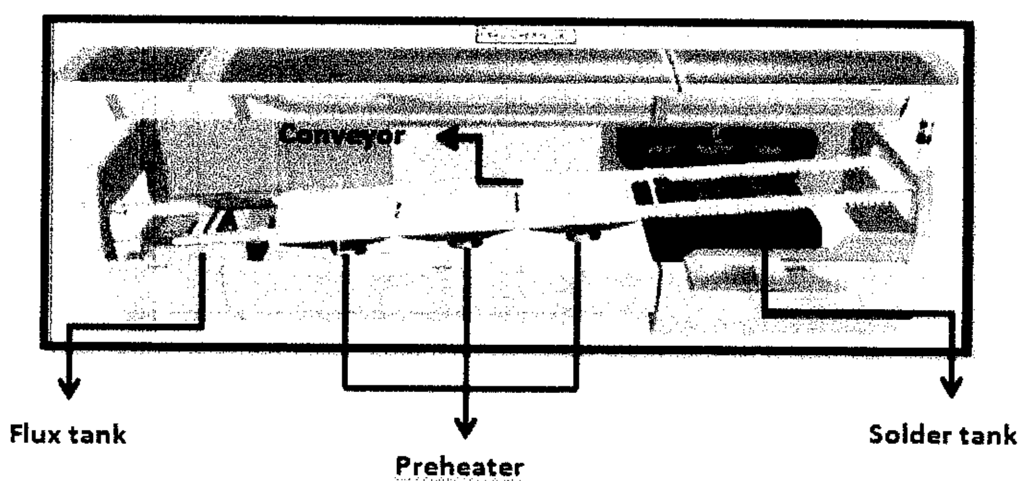


Figure 6: Wave Soldering Machine

Concepts of wave solder machine is to solder electronics component such PTH part to a PCB to form electronic assembly. These PTH part commonly used this machine because some of components has a lots of pin to be solder. Manual solder cannot be used for PTH component and some of them are difficult to be soldered by manually [5]. On the other hand, the components are glued by the placement equipment onto the printed circuit board surface before being run through the molten solder wave.

The characteristic for this wave soldering process are the solder connection is very reliable and also a clean connection. The process is automated and it recycles the flux and solder that is left over. This wave solder does require inspection, some touch ups and also testing. Compare to manual solder process, it produces high productivity and also efficiency process. This wave solder machine has 3 zones, which are fluxing, preheating and soldering zone. A PCB board will load into the machine and will go through these 3 zones, which has specialized tasks before the PTH components soldered into the PCB [6].

The characteristic of wave solder process:

- The solder connection is very reliable and also a clean connection
- The process is automated
- The process reuses the flux and solder that is left over
- It does require inspection, some touch ups, and also testing

2.3 Preheating

The PCB will then enter the preheating zone. The preheating zone consists of convection heaters which blow hot air onto the PCB to increase its temperature. For thicker or densely populated PCBs, an upper pre-heater might be used. The upper pre-heater is usually an infrared heater [7].

Preheating is necessary to activate the flux, and to remove any flux carrier solvents. Preheating is also necessary to prevent thermal shock. Thermal shock occurs when a PCB is suddenly exposed to the high temperature of the molten solder wave [7].

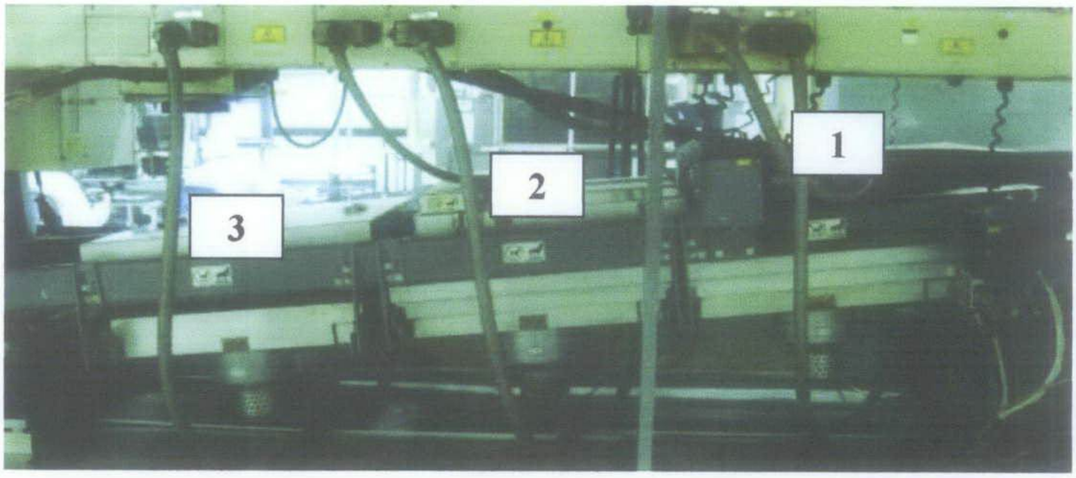


Figure 7: Preheating Zone

2.4 Fluxing

Flux is a chemical cleaning agent which facilitates soldering, brazing, and welding by removing oxidation from the metals to be joined. Two types of fluxers are used:

1. Spray fluxer
    - Spray fluxers consist of a robotic arm which travels from side to side while spraying a fine mist of flux onto the bottom side of the board.

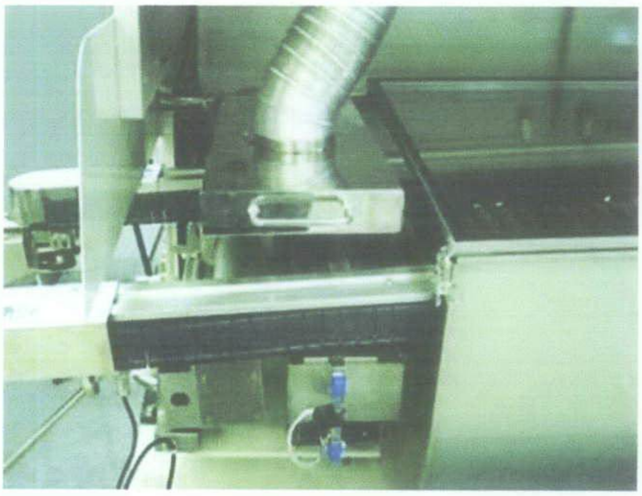


Figure 8: Spray Fluxer

2. Foam fluxer

- The foam fluxer consists of a tank of flux into which a plastic cylinder with tiny holes is immersed; this is sometimes called a "stone".

Figure 9: Foam fluxer

2.5 Soldering

The tank of molten solder has a pattern of standing waves (or, in some cases, intermittent waves) on its surface. When the PCB is moved over this tank, the solder waves contact the bottom of the board, and stick to the solder pads and component leads via surface tension. Precise control of wave height is required to ensure solder is applied to all areas but does not splash to the top of the board or other undesired areas. This process is sometimes performed in inert gas nitrogen (N_2) atmosphere to increase the quality of the joints. The presence of N_2 also reduces oxidization known as solder dross [7].

Solder dross, its reduction and elimination, is a growing industry concern as lead soldering is being replaced by lead-free alternatives at significantly higher cost. Dross eliminators are entering the market and may hold some solutions for this concern.

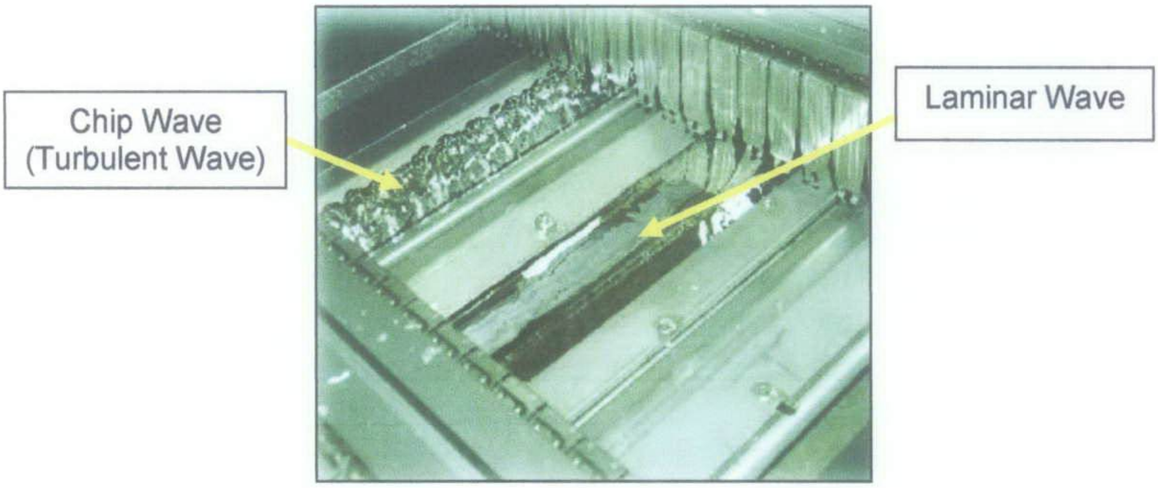


Figure 10: Laminar and Chip Wave

There are 2 types of solder wave. Chip (turbulent) wave and Laminar (lambda or contour) wave. Chip wave is used to solder chips and also PTH components. Only Tahiti and Airbus product used this kind of wave. Laminar or also known as lambda wave is used to solder PTH component only and used for all products in Celestica including Thales Avionics.

CHAPTER 3
METHODOLOGY

3.1 Procedure Identification

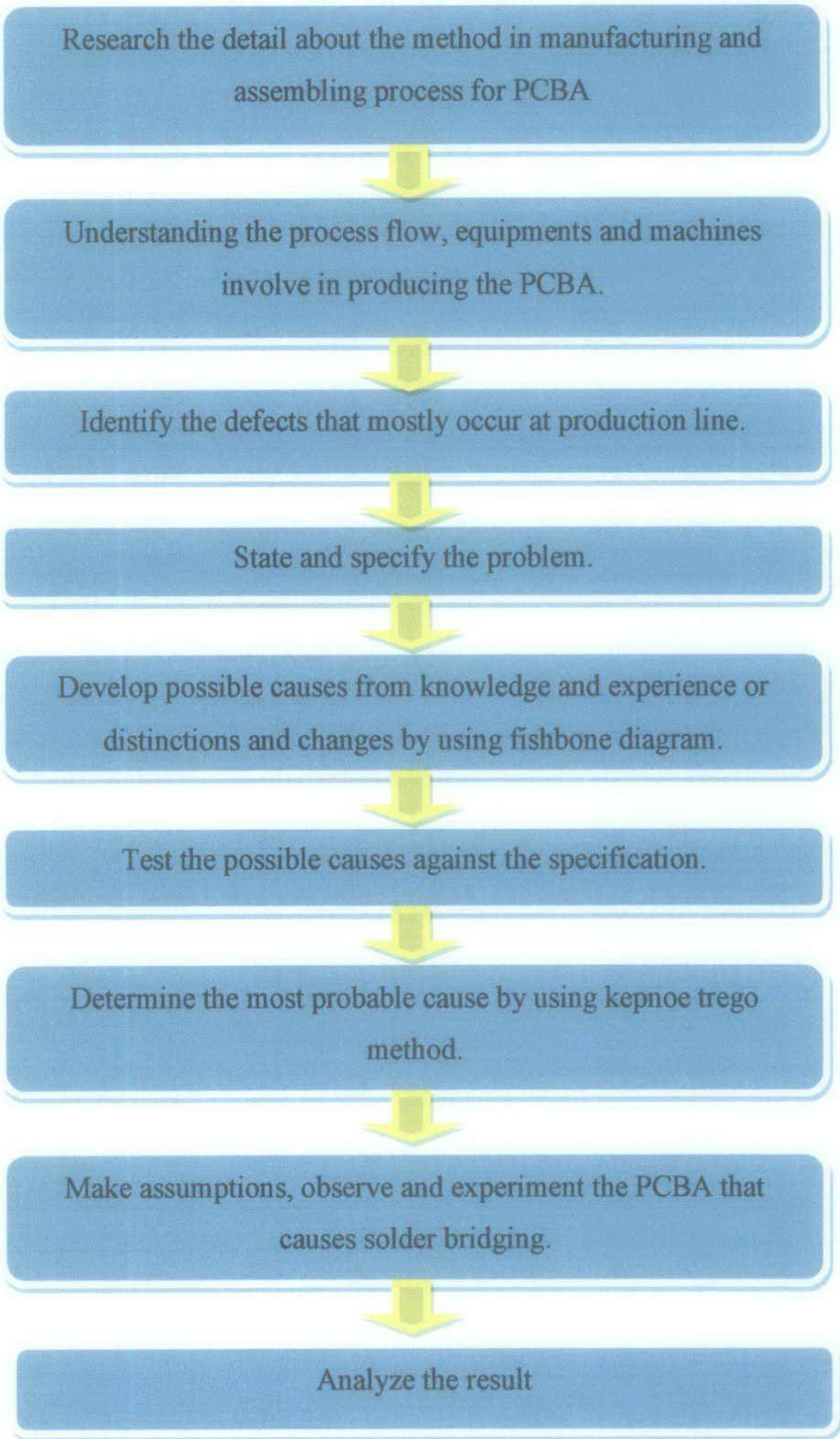


Figure 11: Methodology of the project

For the first step of this project, it will more focus more on understanding the proper step in designing experiments. There are actually three main stage in design of experiment that are planning stage, conducting stage and analysis/interpretation stage.

The first stage is the planning stage, where in this project the planning stage is more on research work in study the details about manufacturing process. On the other hand, investigate the process parameters as the control factor also categories in this stage. Get familiar with the apparatus especially the extrusion and injection molding machine is one of the process in understanding the flow of design of experiment.

After familiar with the machine also the flow of the experiment, the conducting stage will take over. In this project, there are two main job works to be done in this stage that are experimental work and mechanical testing. Experimental work is more on wave soldering machine. While the mechanical testing work is more on testing the specimen of the PCBs part to investigate the defect and effect of the process parameter that been control in the experimental work. The last process flow is analyzing the result data from the mechanical testing stage. In this project, we will investigate the cause and effect of the defect for the PCBs that been produced.

3.2 Understanding the assembly process for PCBA

Bare printed circuit boards are intended for one of two basic rules depends on their design. The first is as a device on which to mount the electronic components. The second is as a device to plug the first device; which to mount the electronic components into. They called it as daughter board or card. The latter called a mother board, backplane or board.

3.2.1 Surface Mount Technology

It is the process for constructing electronics assemblies on PCBA. It consists of three main stations which are solder paste printing for bare board, mount components on printed circuit board (PCB) by using Mounted Machine and reflow process for create connection between solder paste and the components leads [6].

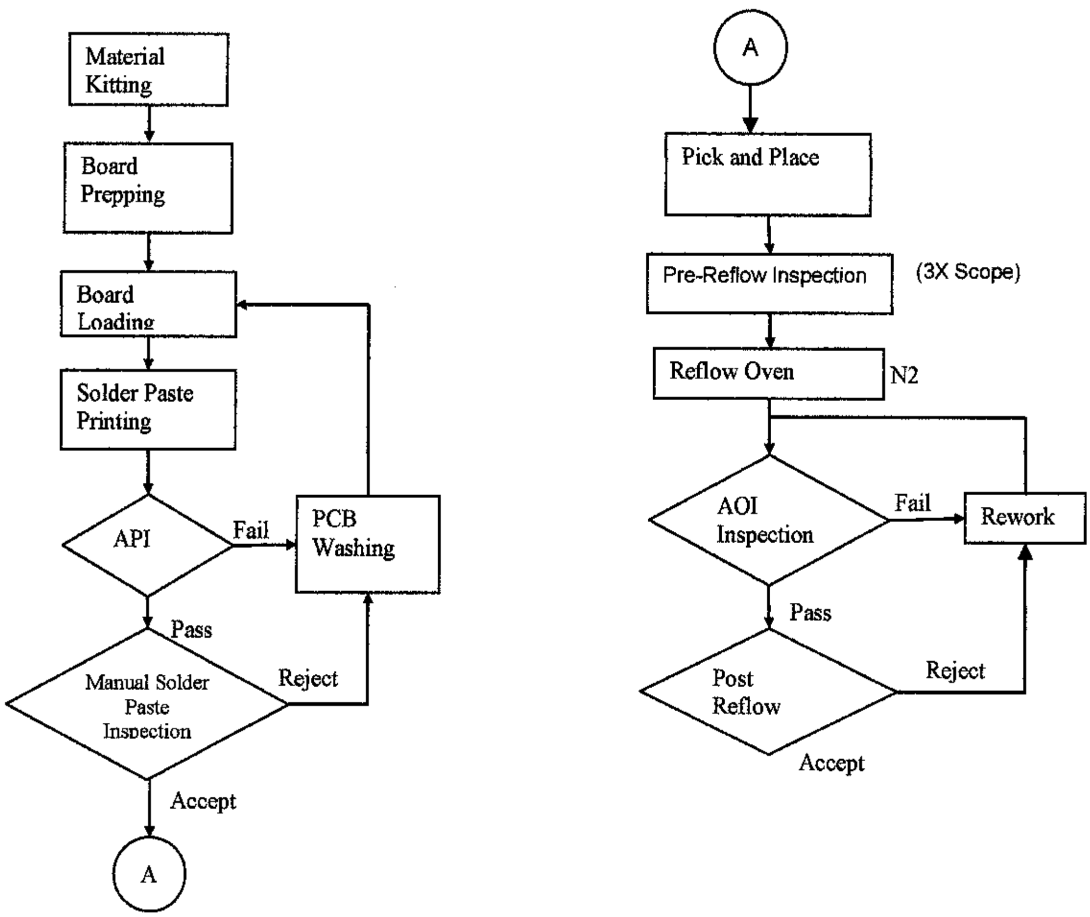


Figure 12: SMT Process Flow

3.2.2 Wave Soldering

Wave soldering is a large-scale soldering process by which electronic components are soldered to a printed circuit board (PCB) to form an electronic assembly. The name is derived from the use of waves of molten solder to attach metal components to the PCB. The process uses a tank to hold a quantity of molten solder; the components are inserted into or placed on the PCB and the loaded PCB is passed across a pumped wave or waterfall of solder. The solder wets the exposed metallic areas of the board (those not protected with solder mask, a protective coating that prevents the solder from bridging between connections), creating a reliable mechanical and electrical connection. The process is much faster and can create a higher quality product than manual soldering of components.

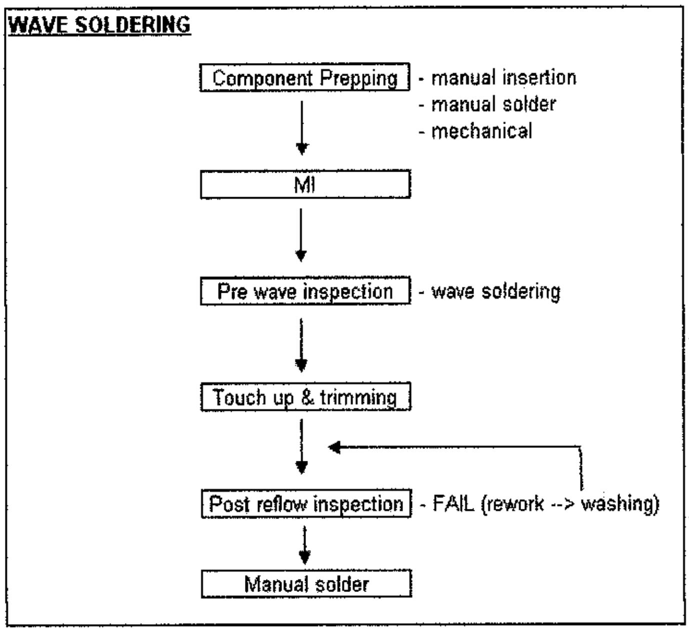


Figure 13: Wave solder flowchart

3.2.3 Conformal Coating

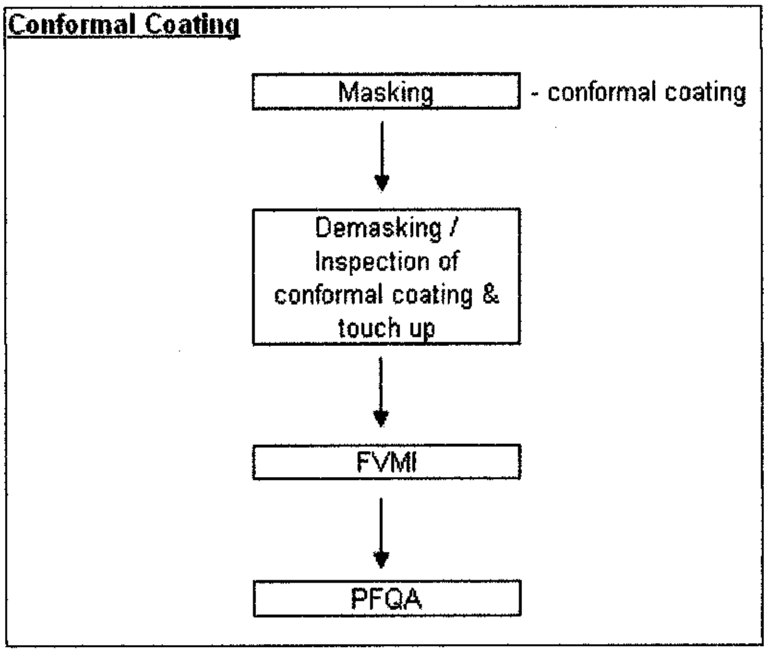


Figure 14: Conformal Coating flowchart

Conformal coating material is applied to electronic circuitry to act as protection against moisture, dust, chemicals, and temperature extremes that if uncoated (non-protected) could result in a complete failure of the electronic system. Most circuit board assembly houses coat assemblies with a layer of transparent conformal coating rather than potting.

Typical robotic processes involve needle & atomized spray applicator, non-atomized spray or ultrasonic valve technologies that can move above the circuit board and spray the coating material in selective areas. Flow rates and material viscosity are programmed into the computer system controlling the applicator so that the desired coating thickness is maintained. This method is highly effective at large volumes as long as the PCBs are designed for the method. However, there are limitations in the select coat process like all the other processes, such as potentially capillary effects around low profile connectors which "suck" up the coating accidentally.

The process quality of dip or dam-and-fill coating and non-atomized spray technology can be improved when necessary by applying and then releasing a vacuum while the assembly is submerged in the liquid resin. This forces the liquid resin into all crevices, eliminating uncoated surfaces in interior cavities.

The differences in application methods can be seen in a comparison presentation. Choice of method is dependent on the complexity of the substrate to be conformably coated, the required coating performance and the throughput requirements.

3.2.4 Back End process

It consists of several processes which are Mechanical Assembly (Frame Assemble and screwing), Adhesive Application (application of araldite, Adekit or Silicone CAFF33) and Manual Solder.

3.3 Understanding the parameters of wave soldering machine

Wave soldering has more variable parameters than any other soldering method. Furthermore, most of these parameters are interdependent in their effect on the soldering result. This is the operating parameters:

- Temperature of solder
- Type of flux
- Intensity of preheating
- Amount of flux deposited per unit board area
- Conveyor speed

3.3.1 Temperature Solder

The temperature of the solder is one of the most basic wave soldering parameters. The standard wave soldering temperature of 250°C (480°F) and close adeherence to this value is ±2-3 °C or ± 4-6 °F. Below is the wave soldering profile for wave soldering machine at CMY. From the wave soldering profile, the peak temperature is in range 214°C to 250°C.

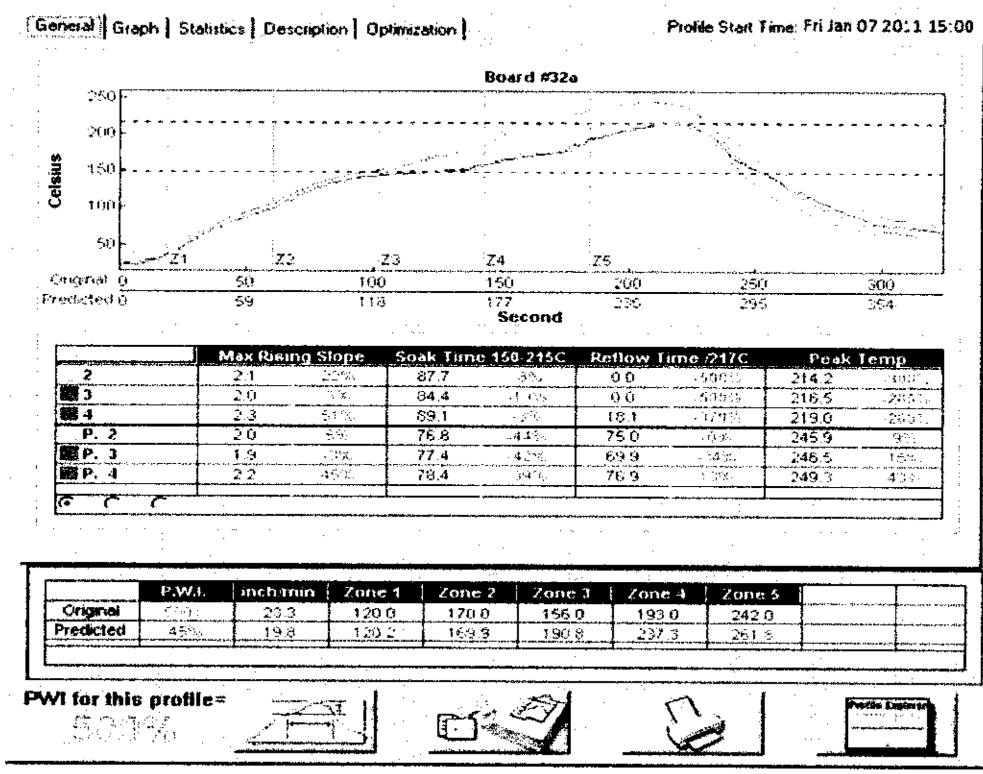


Figure 15: Temperature profile

Before starting the wave soldering process, the technician must carry out a simple check at the beginning of every shift by taking the wave soldering temperature profile. This profile were taken for several times in order to ensure it achieve the standard wave soldering temperature which is 250°C (480°F).

Thermal Profiling

The purpose of taking the thermal profiling is to achieve optimum temperature of PCBA while go through reflow oven or wave. It is because by taking and analyze the thermal profiling, the heat exposes of PCBA can be minimized and the thermal shock of the PCBA can be prevented. Profiling involves measuring the time versus temperature relationship as the product travels through the process. The data typically includes statistics such as peak temperature, soak, time above liquidous and more. The product's profile is crucial to understanding the 'success' of the thermal process relative to the factors that limit the process.

The similarity between both machines while taking the thermal profile is both machines use SlimKIC 2000 as a profiler. From the thermal profiling result, the maximum rising slope, preheat time and peak temperature need to be analyzed. The differences between conventional wave soldering machine and selective wave machine are the usage of the TC wire and how the machine operated while the PCBA and the profiler read the result. For the conventional wave soldering machine, the TC wires are attach to three PTH components, two SMT components, one PCB and one air. While for the selective wave machine the TC wires only need to be attaching to one PTH component and one air. The conventional wave soldering machine is automatically function, the PCBA is put onto the wave pallet and it will go through by conveyor while for the selective wave machine, the PCBA move from pre-heater to the selective solder machine by manual operation.

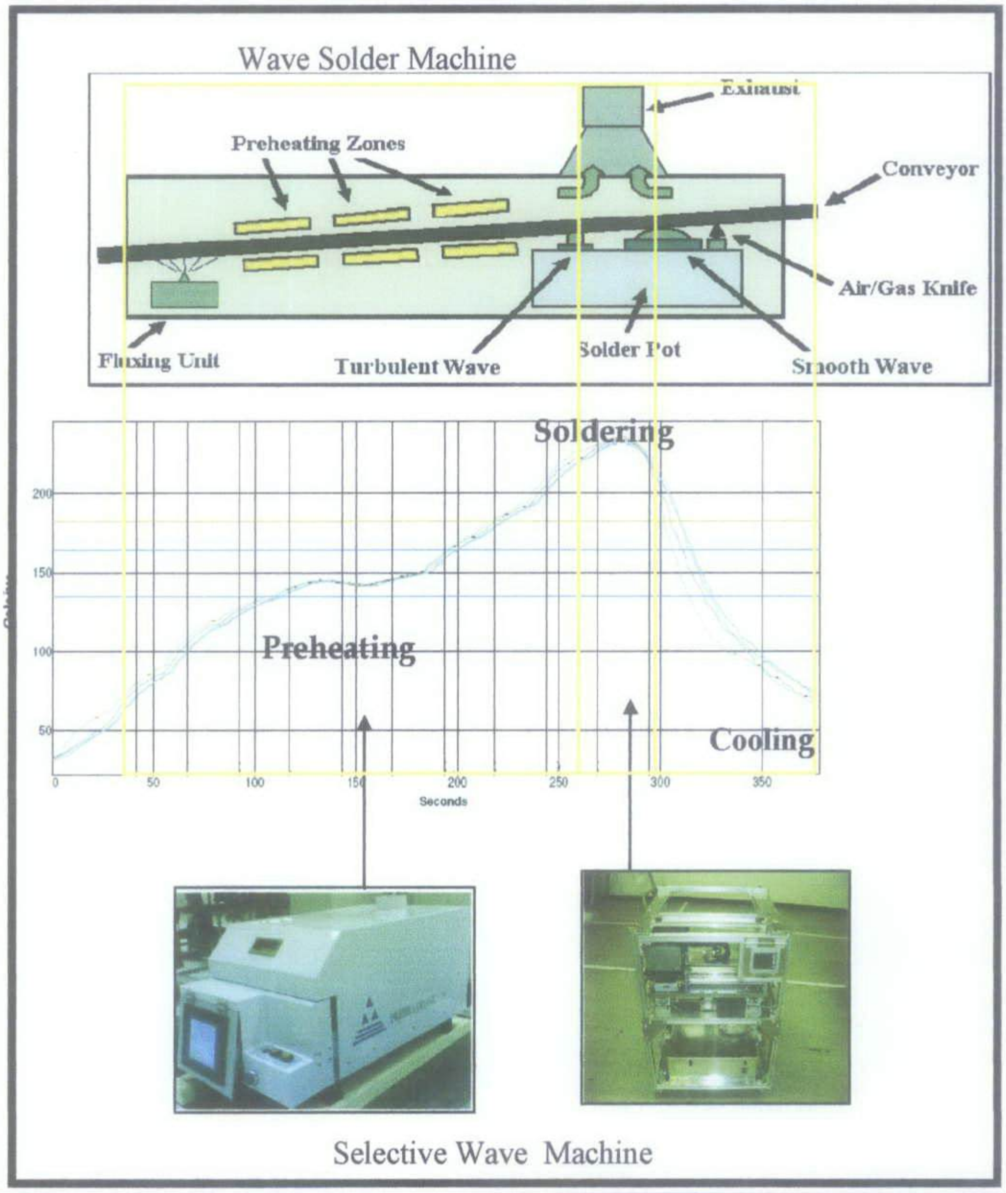


Figure 16: Thermal profiling

3.3.2 Flux

Choosing the right type of flux for a given production line, soldering task or type of board involves a great deal of effort, time and cost. The flux that used should not be acid or zinc based because they will corrode the board and lead parts. The Rosin flux known as RA is not recommended. The acceptable flux is R or RMA.

In order to control and monitoring the flux curves, the flux sample must be warmed or cooled to 20°C / 68°F before its density measured [5].

3.3.3 Intensity of Preheating

Insufficient preheat leaves too much solvent in the flux cover which is therefore more liable to be washed off in solderwave leading to bridging open joints. This factor is particularly critical with double waves where as a substantial portion of the flux cover must survive the passage through the turrbulent wave. Moreover, if the flux is too cool, the solder may not rise through all plated holes and form the required solder meniscus on the upper board surface.

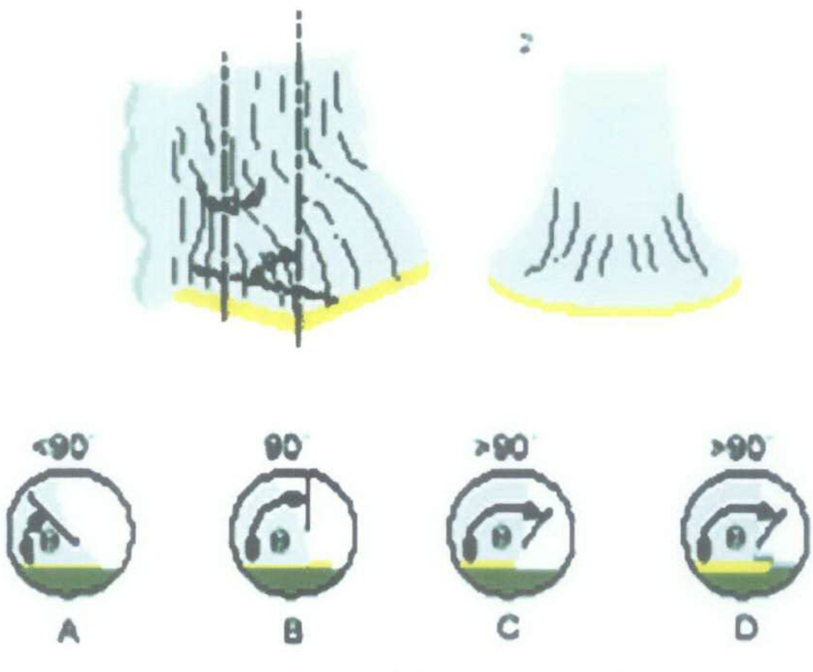


Figure 17: The wetting angle

The solder connection wetting angle from solder to component and solder to PCB termination must not exceed 90°.

3.3.4 Amount of Flux Deposited Per Unit Board Area

This parameter also affects the soldering success, though to a lesser degree than the density and the activity of the flux. The excess flux used means more solvent in the flux cover and the preheater is adjusted accordingly which give a risk of boiling solder-prill formation as the board passes through solderwave. If the boards have to be cleaned after soldering, there is too much flux that reduces the efficiency of cleaning [5]. However, if there is small amount of flux, unfluxed patch will cause soldering faults such as bridges, icicles, solder adhering to the board and the joints especially with low-solid fluxes.

The thickness of the flux cover can be controlled to some extent with the various types of fluxer. But the frequent visual check of the overall appearance of the soldered boards is the best method of ensuring the stability of this important factor. Automatic video surveilance of the output os a soldering line should be capable of giving warning of a mulfunction of the fluxing unit.

3.3.5 Conveyor Speed

The conveyor speed is a critical wavesoldering parameter. The heat received by a board is inversely proportional to the speed at which it travels through the preheating unit at given setting of heating panels. The maximum practiceable soldering speed of wave machine is governed not only by the ability of the solderwave to get the necessary amount of heat into the board within the time available for this, but also by the complexity of its pattern and the density of its population of components [5].

Furthermore, multilayer boards with high heat capacity must travel more slowly than simple single-layer boards. Boards with closely set SMDs and fine pitch multilead components must travel over the wave more slowly to give the chance for solder to flow into the narrow gaps between neighbouring components and to drain away from the fine pattern of leads.

3.4 Problem Solving Method

After understanding all processes and apparatus involved, the root cause identification have been conducted and how the data be analyze. In the first part of this chapter, it will explain the type of defects that encountered and the criteria need to be considered in order to solve this problem.

The cause and effect diagram is used to explore all the potential or real causes (or inputs) that result in a single effect (or output). Causes are arranged according to their level of importance or detail, resulting in a depiction of relationships and hierarchy of events. This can help us search for root causes, identify areas where there may be problems, and compare the relative importance of different causes.

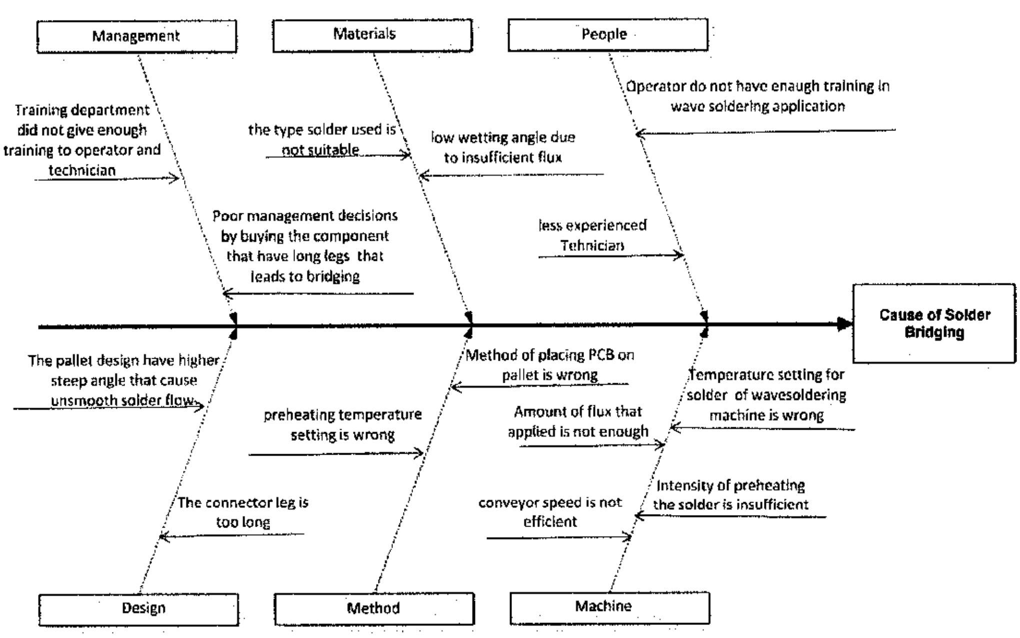


Figure 18: The Fishbone diagram for solder bridging defects

- Management
  - ➢ The project management team was not a possible cause because the issue here is more technical rather than managerial. The team unanimously ignored this category.

- Materials
  - The team also ignored this category because material is not relevant to the problem. After checking the amount of flux and the type of solder; both parameters are suitable for wave soldering process.

- People
  - The team discussed the possibility of people being the cause of the problem. It is accepted as a major cause because a few less experienced technicians and operator handled the machines and application. Inexperience, negligence, and complacency are some reasons for mistakes that can eventually lead to a solder bridging.

- Machines
  - The team discussed the machine being a possible cause. Insufficient or overloading parameters configuration may be a problem leading to solder bridging. The team accepted it as a major possible cause.

- Method
  - The method or way of doing things was considered by the team as a possible cause. Because wrong method of setting the parameters on wave soldering machine can lead to defects. The preheating temperature must be correct in order to avoid the defects. Besides that, the method of placing the PCB on the pallet also may cause solder bridging and it was considered possible cause.

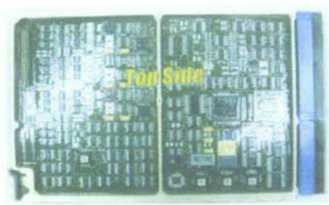
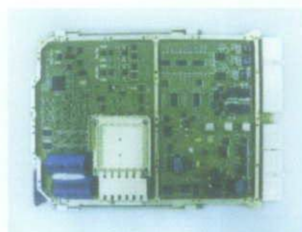
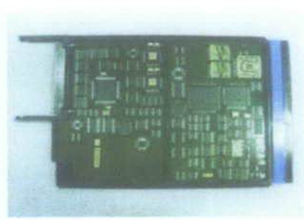
- Design
  - The team discussed the impact of the wrong design that has been used.
  - There is a specification that required by customer for connector:
    - The height of component from PCB must be less than 8.5 mm.
    - The lead protrusion must be less than 1.5 mm.
  - Issues like solder bridging connector leg is too long may cause solder bridging because it may leads to unsmooth solder flow during the

CHAPTER 4
RESULT AND DISCUSSION

This section will be discussed the experiment and the test that have been conducted and how the data be analyze. In the first part of this chapter, it will explain the type of defects that encountered and the criteria need to be considered in order to solve this problem.

4.1 Problem Analysis

From the fishbone diagram, the main cause of the solder bridging is the design of the connector leg is too long. This is because of the problem analysis shows that the main cause is the connector that installed.

	PCB model : E12977/ E12978/ C5571 /C 5572	**PCB model : E13162 / C5969**
Picture of PCB	 	 
WHAT	Both model were installed the connector A1216130BGS that supplied by Tyco Electronics. Solder bridging was found at the connector location only.	Both model were not installed the connector A1216130BGS that supplied by Tyco Electronics. No solder bridging found.

WHEN	The connector was installed before wave soldering process.	There is no installation before wave soldering process.
WHERE	Solder bridging was found at wave soldering station.	No solder bridging was found.
EXTENT	The large numbers of PCB model was affected.	There is no numbers of PCB that affected.

Table 1: Problem analysis by using Kepnoe Trego method

As stated in the methodology chapter, there are basically an experiment will be conducted in identifying the type of defect in manufacturing process. The experiment is done in order to investigate the cause that produce solder bridging. For tension test, the value of the tensile strength will be collect while for flexure test is the loads require bending the material product at the specific point. For each experiment, five samples will be used. The result data for each sample is recorded in a table and the average value for the five samples will be calculated. The purpose of having five samples for each experiment is to reduce the error that may happen during the experiment.

4.2 Data Analysis

The product engineer encountered that the solder bridging was detected at wave soldering station. Solder Bridging occurred for sample board model C6424, C6423, E12977, E12978, C5571 and C5572 at location J1 and P1. The connector that involved for location J1 and P1 is supplied by Tyco Electronics and the part number is A1216130BGS.

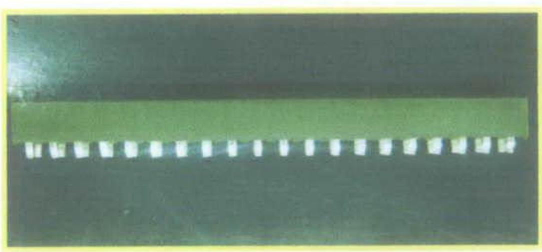


Figure 19: the picture of Connector (A1216130BGS)

The location for solder bridging for model C5571 and C5572:

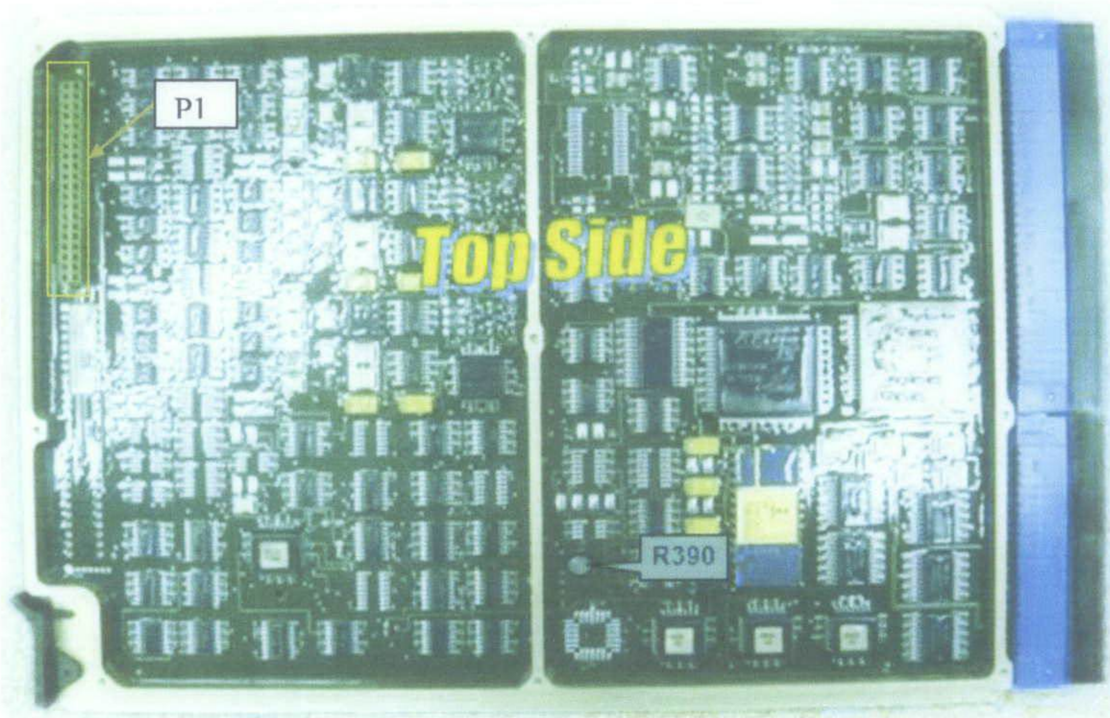


Figure 20: PCB (model C5571 and C5572)

The location for solder bridging for model E12977 and E12978:

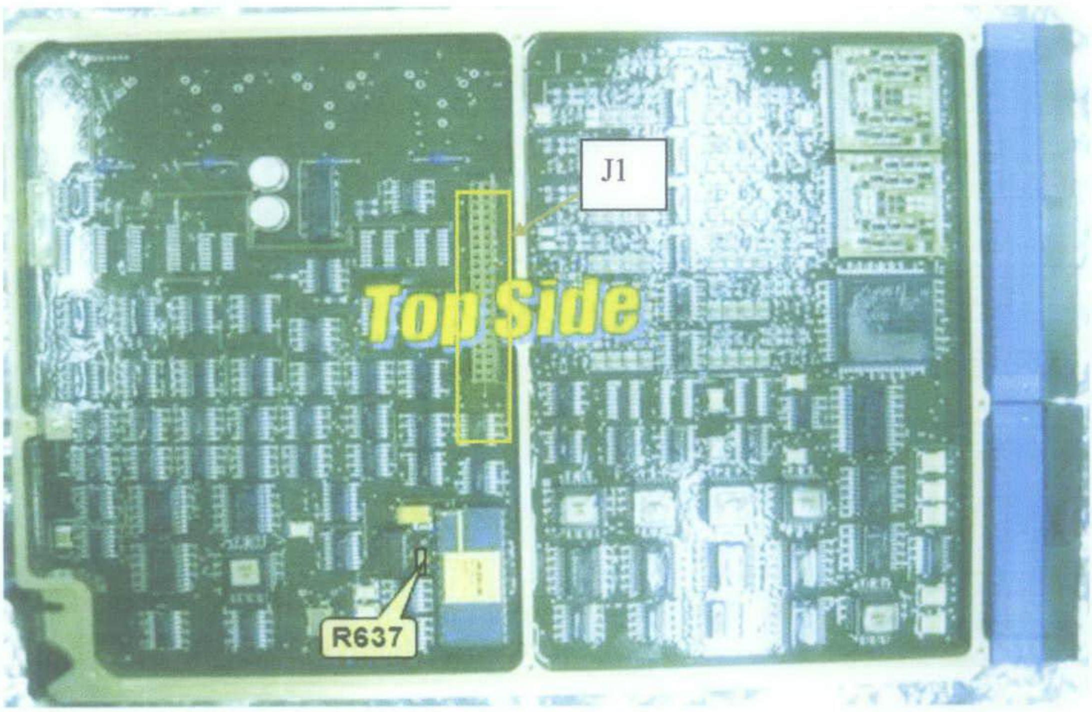


Figure 21: PCB (model E12977 and E12978)

4.3 Observation

After doing some observation and investigation, the causes that affected solder bridging is the lead of the component is too long. From this problem, it will cause solder turbulence at the location. The solder turbulence means that the solder cannot go smoothly out from the opening. Other than that, we had identified that the component leg is too long will cause solder bridging because the leads will inhibit the smoothly flow of the solder.

There is a specification that required by customer for connector:

- The height of component from PCB must be less than 8.5 mm.
- The lead protrusion must be less than 1.5 mm.

4.3.1 Component Leg Too Long

We had specified component leg lengths according to IPC A 610 standard specification and trim the leads according to the specification. There are some modification was made by reducing the lead in order to avoid solder bridging.

4.3.2 Before lead prepping

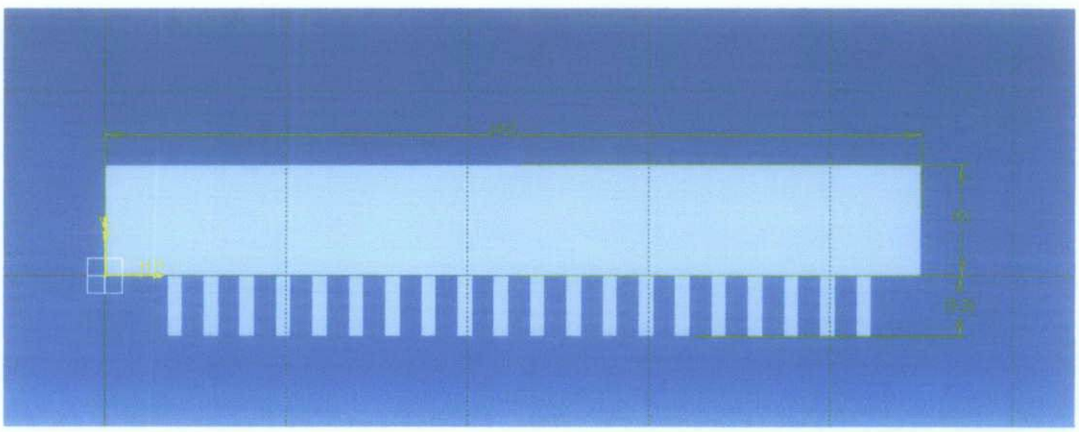


Figure 22: The dimension before lead prepping

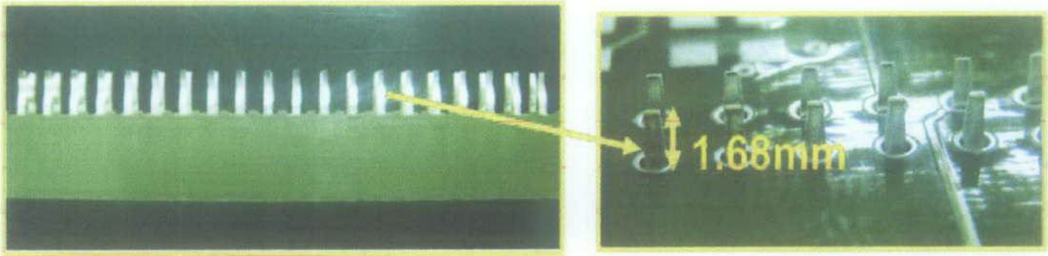


Figure 23: The picture before lead prepping

The thickness of the PCB is 1.60 mm and the lead protrusion before lead prepping is 1.68mm. This lead protrusion must followed customer requirement which is must be less than 1.5 mm. The lead protrusion for this component does not meets the specification and too long for wave soldering process. After wave soldering process, there are solder bridging defects at J1 location.

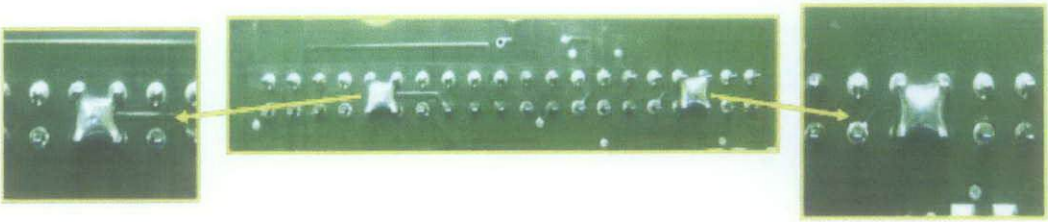


Figure 24: Solder bridging at location J1

4.3.3 After lead prepping

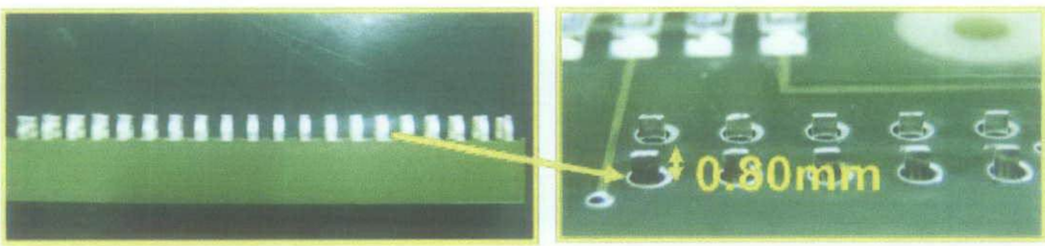


Figure 25: The picture after lead prepping

After reducing the lead protrusion to 0.8mm, there is no solder bridging after wave soldering process.

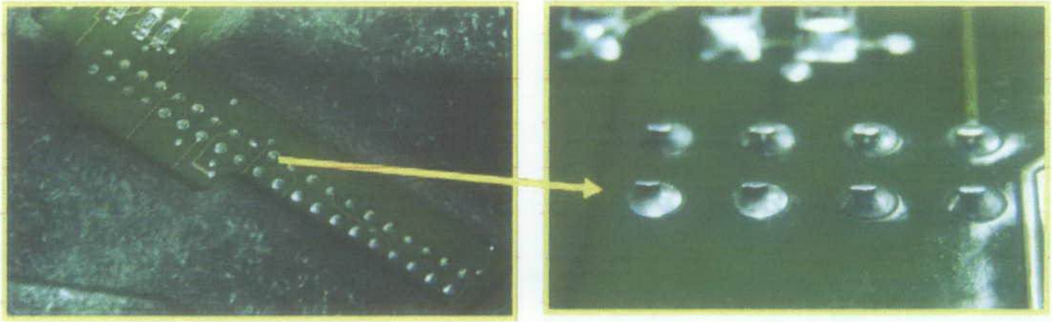


Figure 26: The picture after wave soldering process

The measurement of lead protrusion can be measured by using gauge.

Figure 27: Gauge 1.5 mm (side)

Figure 28: Gauge 1.5 mm

4.4 Evaluation Result

This is the result after made some modification to the lead component for affected model at location J1.

Model : E12977AB01			
No	**Board S/Number**	**Loc.**	**Defect**
1	MYAM07100810	J1	No Bridging
2	MYAM07100828	J1	No Bridging
3	MYAM07100815	J1	No Bridging
4	MYAM07100806	J1	No Bridging
5	MYAM07100819	J1	No Bridging

Model : E12978AB01			
No	**Board S/Number**	**Loc.**	**Defect**
1	MYAN05100677	J1	No Bridging
2	MYAN05100656	J1	No Bridging
3	MYAN05100651	J1	No Bridging
4	MYAN05100646	J1	No Bridging
5	MYAN05100637	J1	No Bridging

Model : C6423AA			
No	**Board S/Number**	**Loc.**	**Defect**
1	MYA610103154	J1	No Bridging
2	MYA610103109	J1	No Bridging
3	MYA610103110	J1	No Bridging
4	MYA610103105	J1	No Bridging
5	MYA610103120	J1	No Bridging

Model : C5571AABM3			
No	**Board S/Number**	**Loc.**	**Defect**
1	MYA410100436	J1	No Bridging
2	MYA410100442	J1	No Bridging
3	MYA410100400	J1	No Bridging
4	MYA410100469	J1	No Bridging
5	MYA410100407	J1	No Bridging

Model : C5572AA			
No	**Board S/Number**	**Loc.**	**Defect**
1	MYA910100549	J1	No Bridging
2	MYA910100509	J1	No Bridging
3	MYA910100520	J1	No Bridging
4	MYA910100519	J1	No Bridging
5	MYA910100489	J1	No Bridging

Model : C6424			
No	**Board S/Number**	**Loc.**	**Defect**
1	MYAL10100587	J1	No Bridging
2	MYAL10100581	J1	No Bridging
3	MYAL10100601	J1	No Bridging
4	MYAL10100585	J1	No Bridging
5	MYAL10100582	J1	No Bridging

Table 2: the evaluation result for solder bridging on PCBA

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Based on the data that we get, the solder bridging is contributed by one major problem which is the component leg is too long. We had identified that the connector leg too long will cause solder bridging because the leads will obstruct the solder to flow smoothly.

5.2 Recommendation

1. Specify all the component leads before wave soldering process occur.
2. Ensure all components lead meet the specifications.
3. Change the design of the connector component by reducing the leg of the component.

	Before modification	After modification
Lead length	3.3 mm	2.6 mm
Lead protrusion	1.7 mm	1.0 mm
Defect	Solder bridging	No solder bridging

Table 3: The comparison before and after modifications

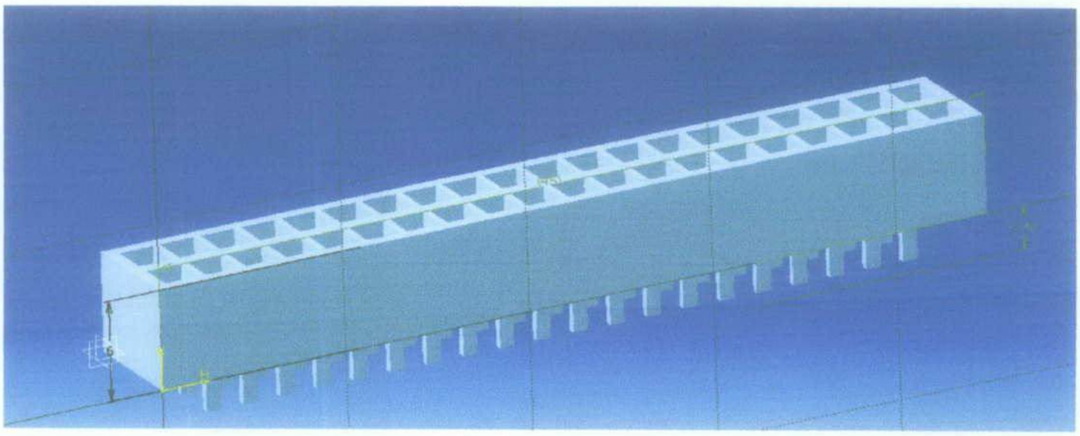


Figure 29: The dimension of new design of connector (3D view)

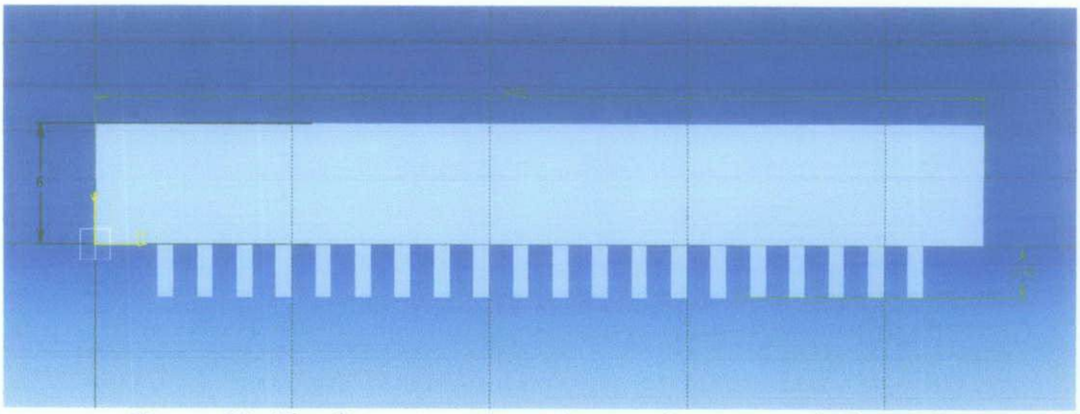


Figure 30: The dimension of new design of connector (side view)

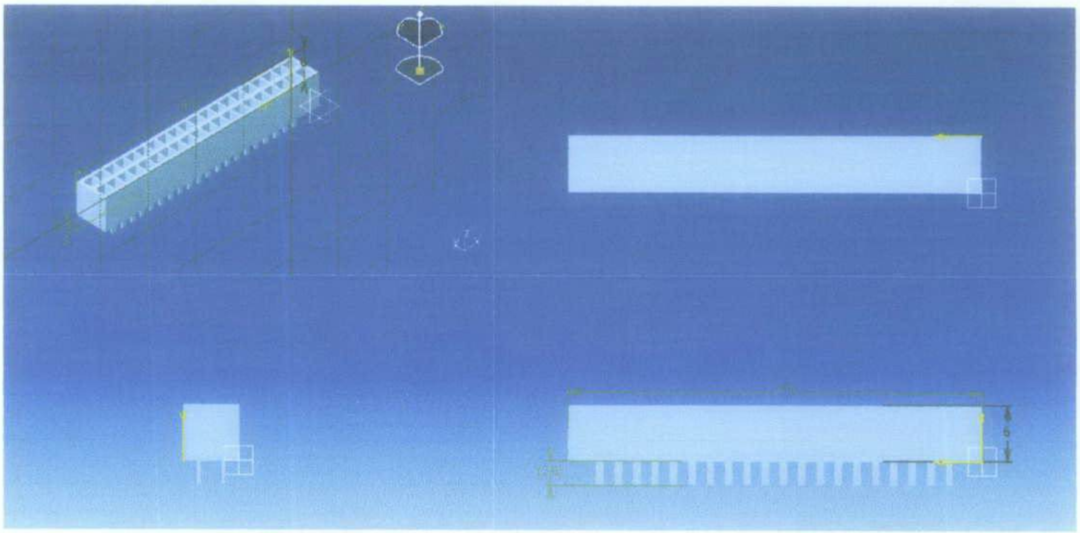


Figure 31: The dimension of new design of connector from all view

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APPENDICES

APPENDIX 1: CELESTICA ACRONYMS

5S – Five pillars of the visual workplace

A&D – Aerospace & Defense

AMS – Automated Manufacturing Services

AOI – Automated optical inspection

APS – Advanced planning system

API – Annual physical inventory

AQL – Acceptable quality level

ASD – Automated stencil design

ASQ – American Society for Quality

AVL – Approved Vendor Listing

BGA – Ball grid array (technology)

BIOS – computer firmware that directs many basic functions of the operating system, as booting and keyboard control

BOM – Bill of Material

BTO – Build to order

CBR – Celestica Brazil (Hortolandia)

CCR – Celestica Czech Republic (Kladno, Rajecko)

CDG – Celestica Dongguan

CDT – Central design team

CEO – Chief executive officer

CESOP – Celestica Employee Share Ownership Plan

CFM – Continuous flow manufacturing

CHK – Celestica Hong Kong

CHY – Celestica India (Hyderabad)

CIP – College internship program

CIS – Continuous Improvement Summary

CJH – Celestica Johor Bahru (Malaysia)

CJP – Celestica Japan (Miyagi)

CJQ - Celestica JinQiao (Shanghai EMS)

CLC – Celestica Learning Centre

CMN – Celestica Arden Hills

CMY – Celestica Malaysia (Kulim)

CNE – Celestica Manchester

CPH – Celestica Philippines (Cebu)

CPI – Continued process improvement

CPN – Customer part number

CSA – Canadian Standards Association

CSAT – customer satisfaction

CSG – Celestica Singapore

CSJ – Celestica San Jose

CSP – Celestica Spain (Valencia)

CSS – Celestica Song Shan Lake

CSU – Celestica Suzhou

CTH – Celestica Thailand

CTI – Celestica Team Incentive

CTO – Celestica Toronto

DFA – Design for Assembly (mechanical)

DFF – Design for Fabrication (PCB/PWB)

DFT – Design for Test (in circuit PCB)

DFM – Design for Manufacturability (PCBA)

DGR – Daily going rate

DL – Direct labor

DMAIC – Define, Measure, Analyze, Improve, Control

DOS – Days of supply

DPU – Defects per unit

DT – Design team

EC – Engineering change

EE – Employee

EHS – Environmental Health & Safety

EH&S – Environmental Health & Safety

EMS – Electronics Manufacturing Services

ENG – Engineering

EOL – End of life

ESD – Electro-static discharge

FA – Failure analysis

FGI – Finished goods inventory

FMLA – Family medical leave of absence

GM – General Manager

HR – Human resources

HRDW – Human resources data warehouse

ICT – Information & communications technology

IE – Industrial engineering

IEC – Industrial engineering consultant

IIP – Industry internship program

IL – Indirect labor

IMS – International Manufacturing Services

IPC – Interconnecting / Packaging (Electronic) Circuits

IPN – Internal part number

IRC – Information resource centre

ISO – International Organization for Standardization; International Standards Organization

IT – Information Technology

JIT – Just in time

JOBOPPS – Job opportunities

Kaizen – a Japanese term meaning continuous improvement; striving for perfection by continually removing successive layers of waste as they are discovered

L&D – Learning and development

LAN – Local area network

MBB – Moisture barrier bag

ME – Manufacturing engineer (site level)

MFG – Manufacturing

MGR / MGMNT - Manager

MLOA – Medical leave of absence

MP – Machine programming

MPI – Manufacturing process instructions

MPN – Manufacturer part number

MPS – Manufacturing process standard (corporate)

MRP – Manufacturing resource planning

MSD – Moisture sensitive device

MSDS – Material Safety Data Sheets

MTS – Manufacturing test standard (corporate)

MVA – Material value add

NCM – Non-conforming material

NDF – No defect found

NED – Neutralized engineering data

NEO – New employee orientation

NPI – New Product Introduction

ODM – Original design manufacturer

OEE – Overall equipment effectiveness

OEM – Original equipment manufacturer

OFE – Opportunities for error

OJT – On the job training

Quos – Quality of Service

OSHA – Occupational Safety and Health Act

OSP – Organic solderability preservatives

OTD – On time delivery

P & L – Profit & loss

PCA DFM – Printed circuit assembly design for manufacturability

PCB – Printed circuit board (bare board)

PCBA – Printed circuit board assembly

PE – Process engineer (site level)

PM – Preventive maintenance

PTH – Pin through hole

PWB – Printed wiring board (bare board)

QA – Quality Assurance

QMX – Quality Management System (Data base used to store documents; includes policies, procedures, work instructions & forms)

RMA – Return material authorization

RMS – Retained material savings

RoHS – Restriction of hazardous substances; refers to "lead free"

RTV – Return to vendor

RTVR – Return to vendor request

SAP – "Systeme, Anwendungen, Produkte" German for "Systems Applications and Products"

SCM – Supply chain management

SMT – Surface mount technology

SN – Serial number

ST – Study team

TBC – To be confirmed

TBD – To be determined

TCO – Temporary change order

TPM – Total preventive maintenance

TQM – Total quality management

USB – (Universal Serial Bus) Interface to connect peripheral devices

WIP – Work in process

UTBB – Unit To Be Burned

ATP – Acceptance Test Procedure

PS – Power Supply

P/N – Part Number

APPENDIX 2: WAVE SOLDERING PROCESS DEFECTS:

For wave soldering, there are some types of defects, which are:

- Icycles
- Blow Holes & voids
- Bridging
- Dewetting / Non wetting
- Webbing
- Opens
- Excess solder
- Insufficient solder fill
- Disturbed joints

1) Icycles

It can be recognized by flag shaped extensions of the solder fillet. It was caused by insufficient flux, lack of nitrogen for increase the surface tension, and also the pot temperature is too low.

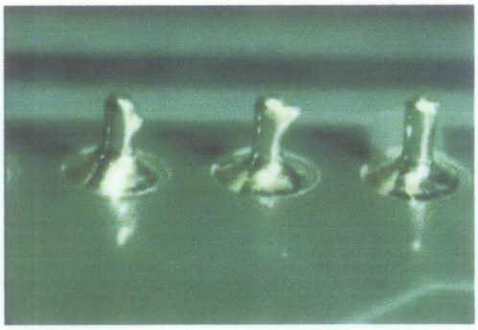


Figure 1: Icycles

2) Blow Holes & voids

It can be recognized by holes or eruptions in the solder fillet.

Figure 2: Blow Holes and voids

3) Bridging

It can be recognized by solder extending between two or more connections causing a short circuit. The causes of this bridging are solder level is too high, lack of flux, preheating temperature is too high and pot temperature is too low.

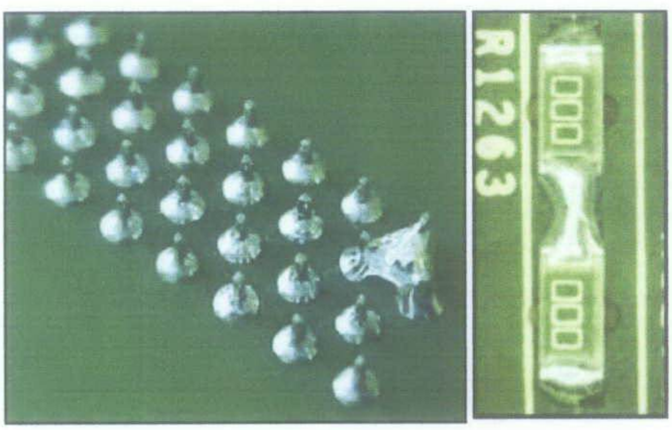


Figure 3: Bridging

4) Dewetting / Non wetting

It can be recognized by metal wetting initially, then pulling back to form droplets of solder on the surface.

Figure 4: Dewetting

5) Webbing

It can be recognized by a spider web like extension of solder across the non conductive portion of the PCB. It caused by insufficient of flux when accompanied by bridging or icycling and also the existent of dross in the wave.

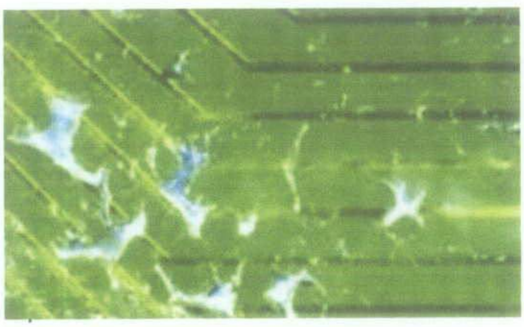


Figure 5: Webbing

6) Opens

It can be recognized by a pull back of solder to expose the surface to be soldered. It usually caused by:

1. Solder level too low
2. Lack of flux
3. Surfaces too heavily oxidized due to the burned flux
4. Low temperature solder
5. Wall pallet too close
6. Lack of Nitrogen (increase the surface tension)

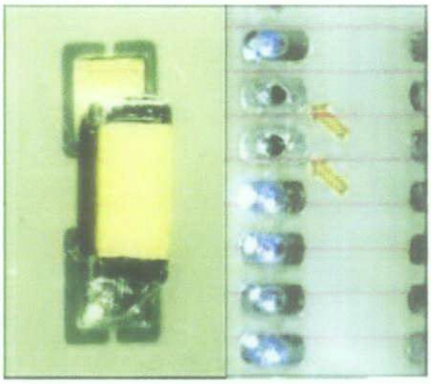


Figure 6: Opens

7) Excess solder

It can be recognized by unable to see contours of lead. The insufficient of flux, the solder level is too high, and the low temperature of preheat or solder may caused the defect.

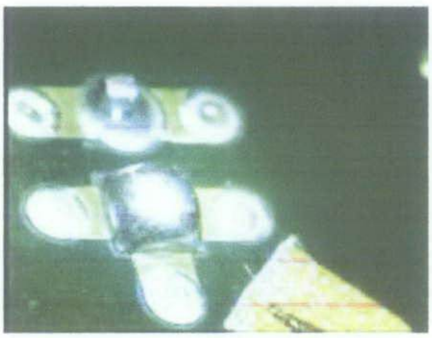


Figure 7: Excess solder

8) Insufficient solder fill

It can be recognized by unable to see on the top of the platted hole.

9) Disturbed joints

It was a rough and dull finish on the fillets in conjunction with unacceptable mechanical strength of the joint.

The causes of this defect are:

- Movement while joint is still molten
- Conveyor vibration
- Ratio lead/hole too high
- Solder temperature too high

APPENDIX 3: STEPS FOR THERMAL PROFILING

KIC 2000 is used as the software to control or manage the profile board when the PCB undergoes thermal profiling.

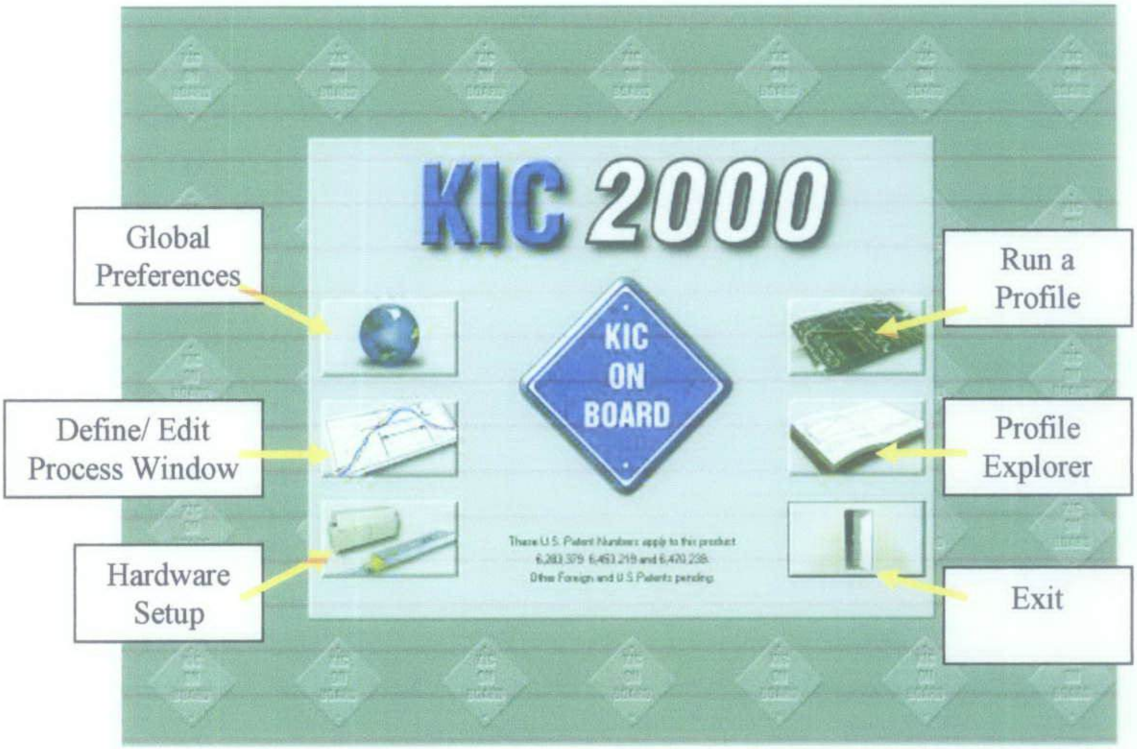


Figure 8: KIC2000 software

Method:

1. Global Preferences was chosen to setup the unit of measures. Differ profiling will result to differ unit of measures.
    a. For Wave, there are several setup to be determined:
        i. Conveyer speed unit (Meter/minute)
        ii. Distance (usually in inch)
        iii. Product start temperature (in 40 degrees)
        iv. Profile Hardware (datalogger)

2. **Define/ Edit Process Window** was chosen to select process window, and also to see either the specification is correct with board needed.

Figure 9: Define/ Edit Process Window

3. To see the SLIM KIC 2000 status, **Hardware Status** was clicked. Here, all current condition will be display.

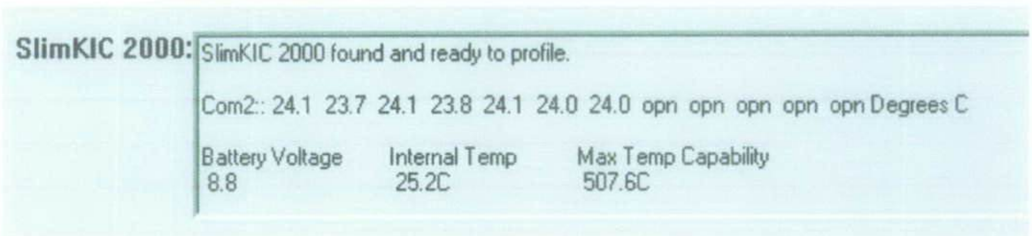


Figure 10: Hardware Status

4. Finally, the button **Run a Profile** was click. Here, there are some field that the technician should fill.
    a. **PRODUCT NAME**:
        i. name of product
    b. **PROCESS WINDOW**:
        i. set process window name
        ii. already set up followed the Edit/Define Process Window step
    c. **APPLICATION**:
        i. Wave solder on – Wave
    d. **OVEN NAME**:
        i. Set the oven name according to the line and type of oven
    e. **PROFILE DESCRIPTION**:
        i. Describe the profile, the name of person take the profile, his shift, the board name and so on.

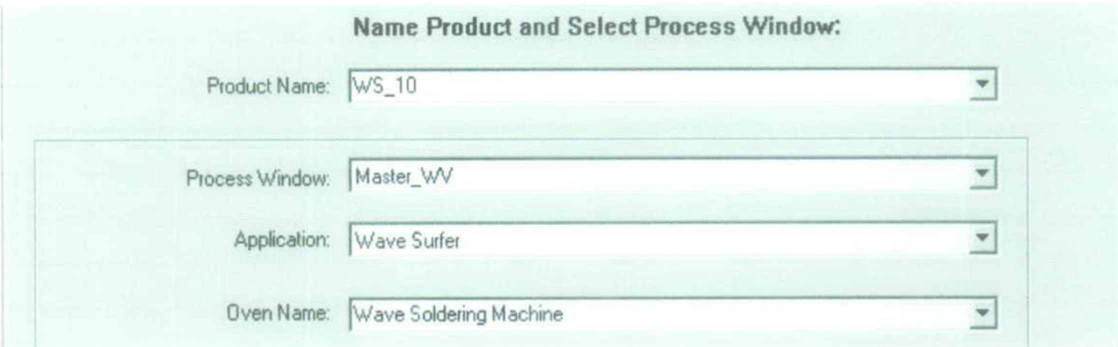
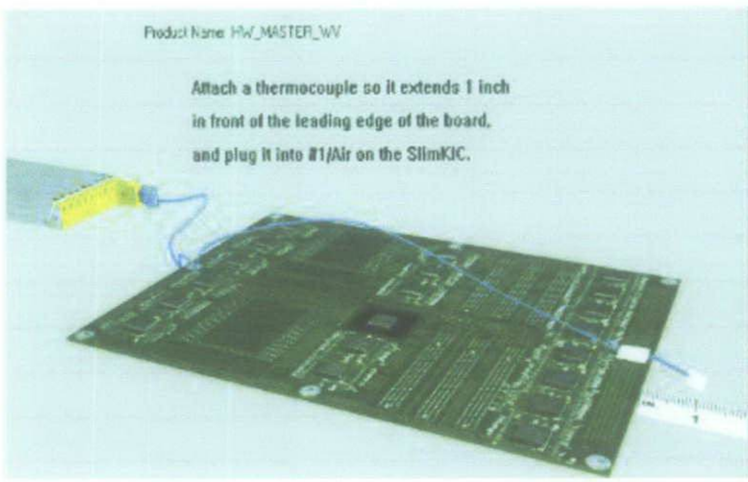
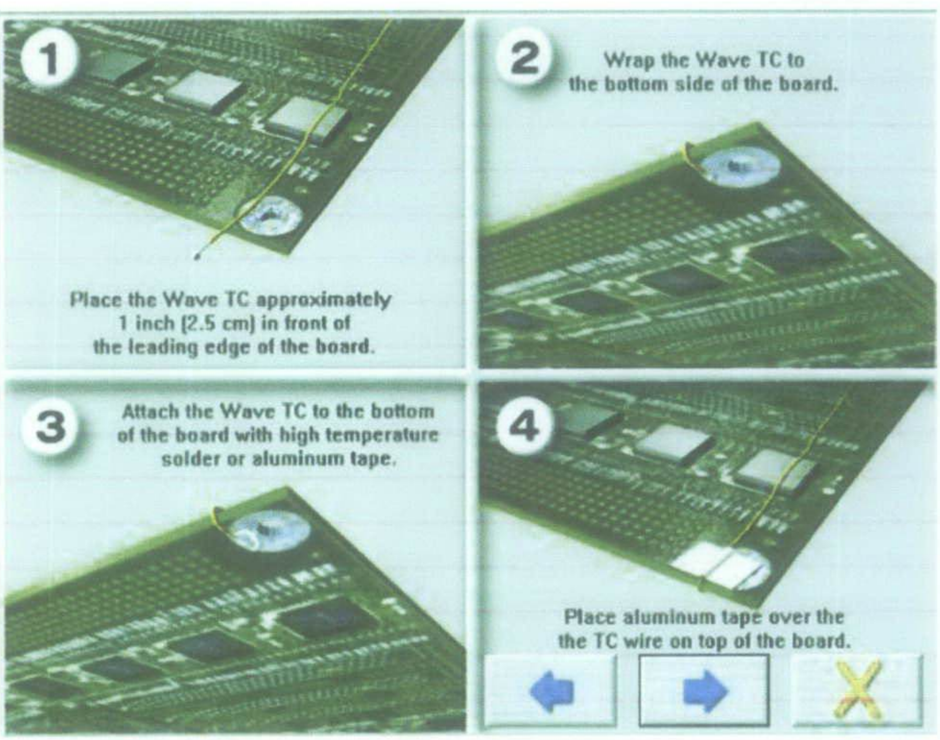


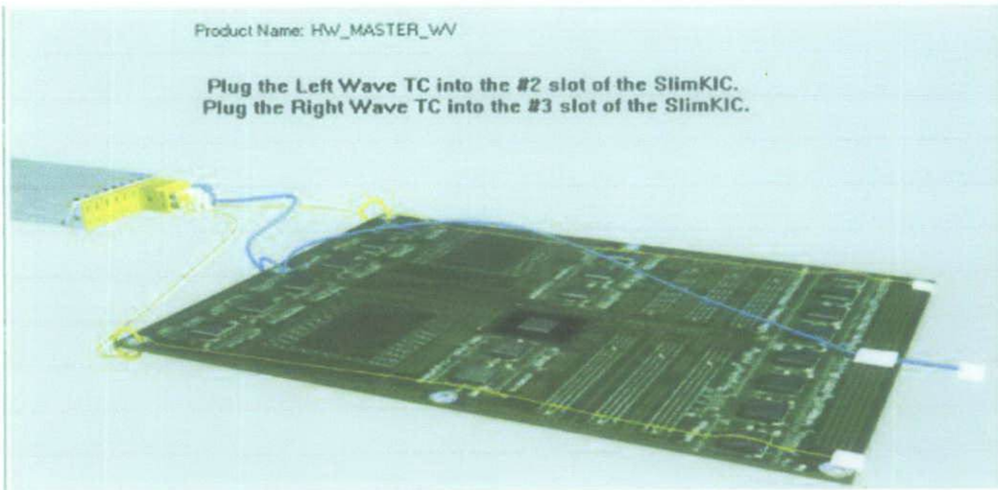
Figure 11: Run a Profile

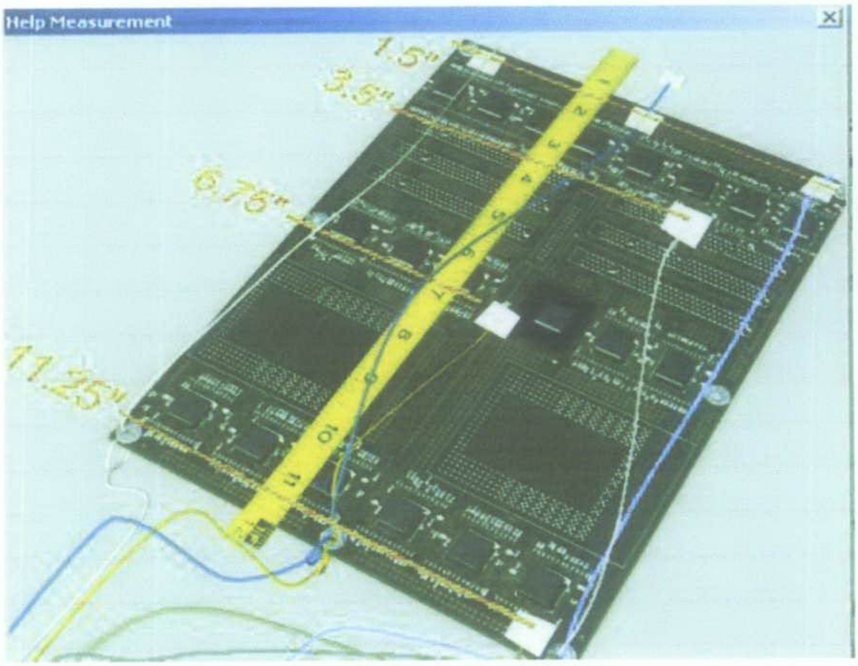
5. Click **next arrow** button



6. Click **next arrow** button

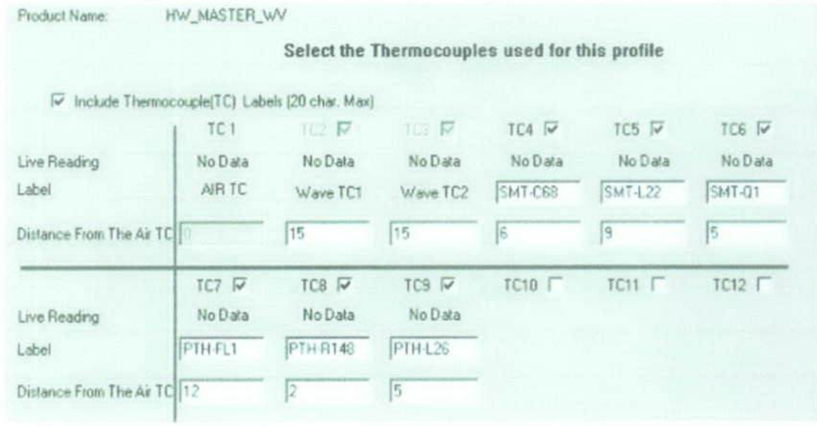




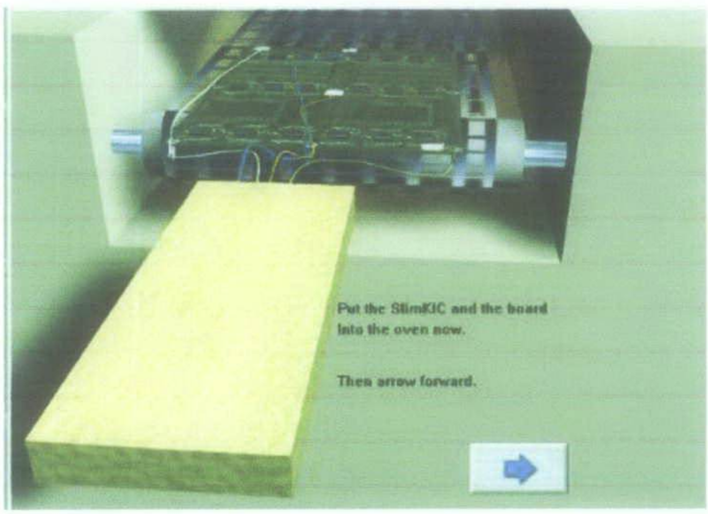


7. Click **next arrow** button

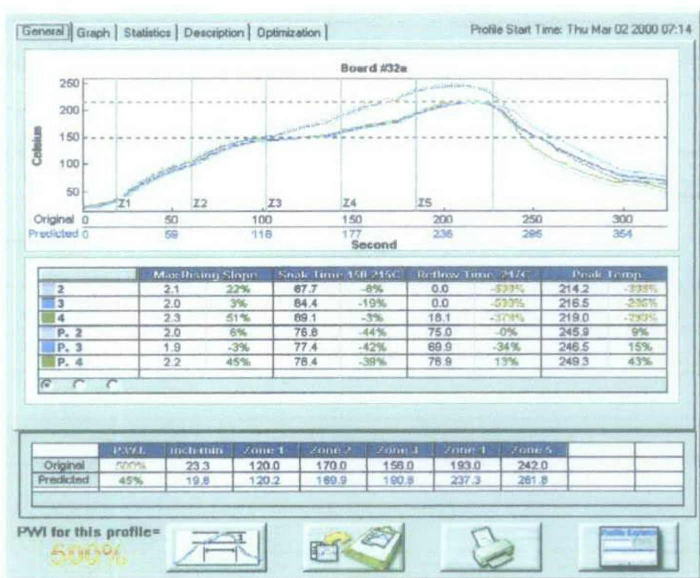
8. Click **next arrow** button



9. Then, load the profile board and SLIM KIC into oven.



10. Finally, download all the data into the program and run the result.



APPENDIX 4: PROGRAMME SETUP FOR WAVE SOLDER MACHINE

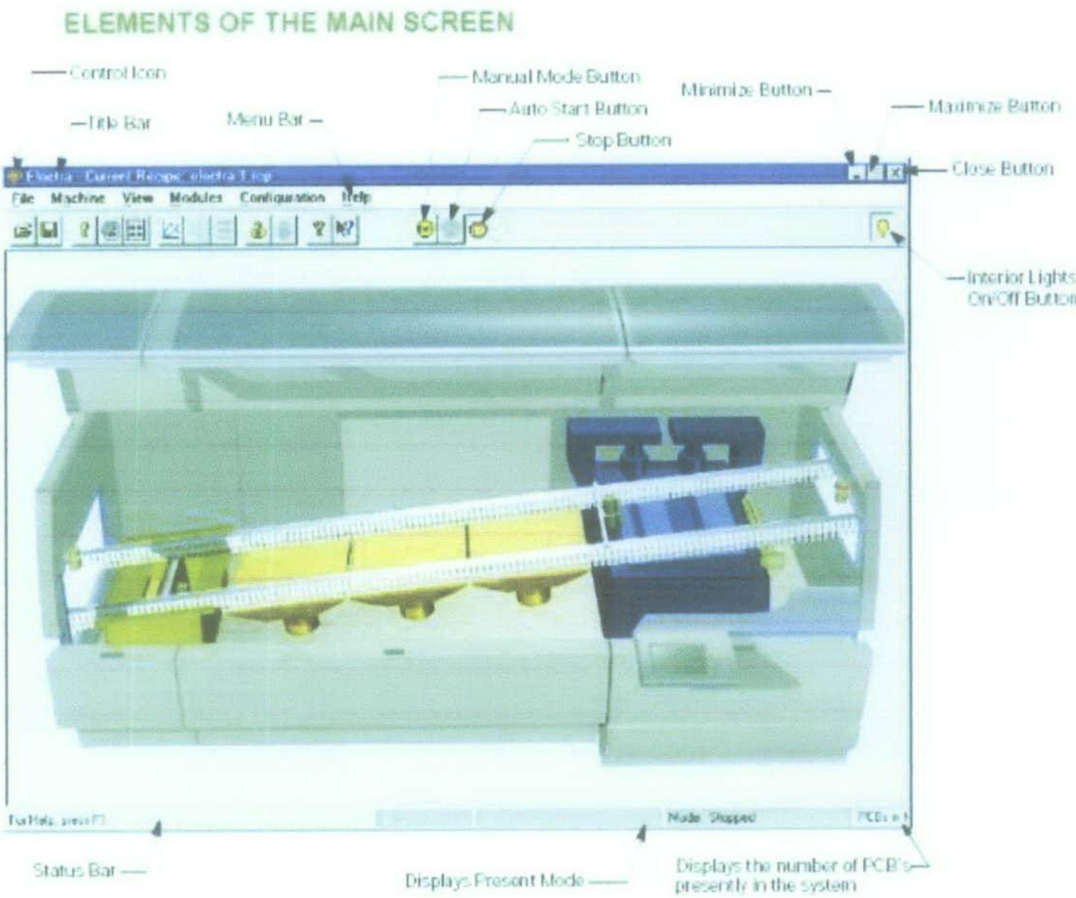


Figure 12: Electra Software main screen

For programme setup wave soldering machine, the Electra Software was used to control and manage board for loading. This software also used for setting the parameter for every recipe for every model.

Below are the steps for setting and start up the programme:

1. Log on for adjust the setting in the recipe (if necessary). Here, the technician will enter the password into the system before they logon to system.

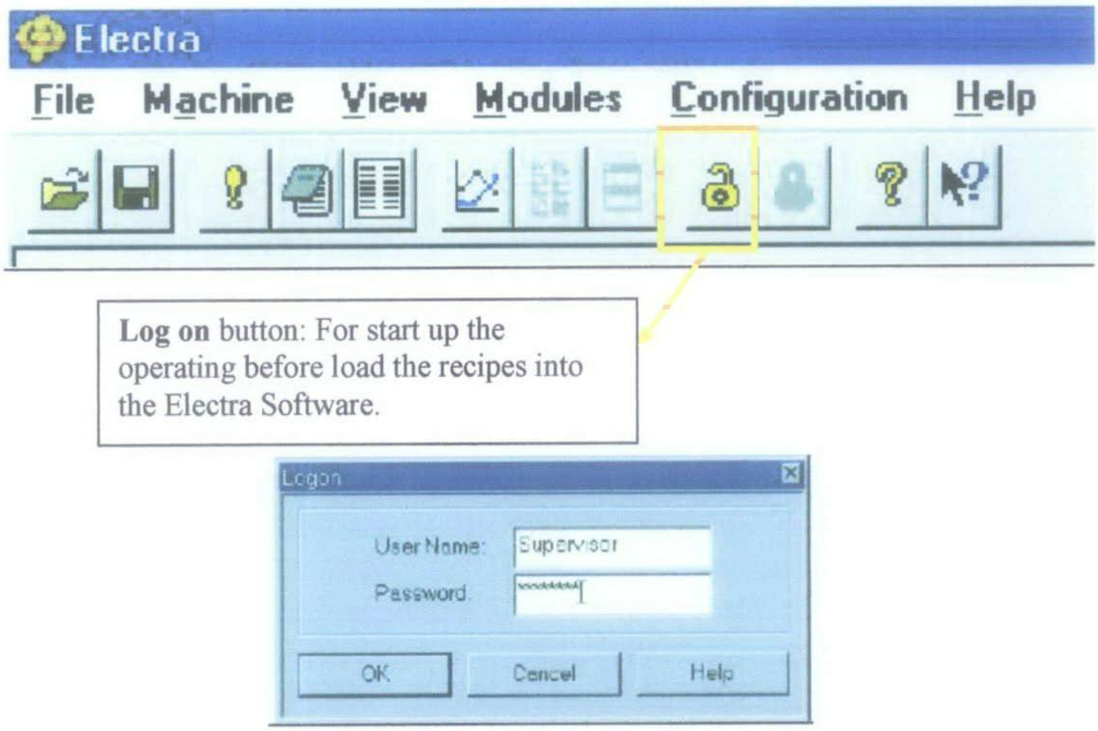
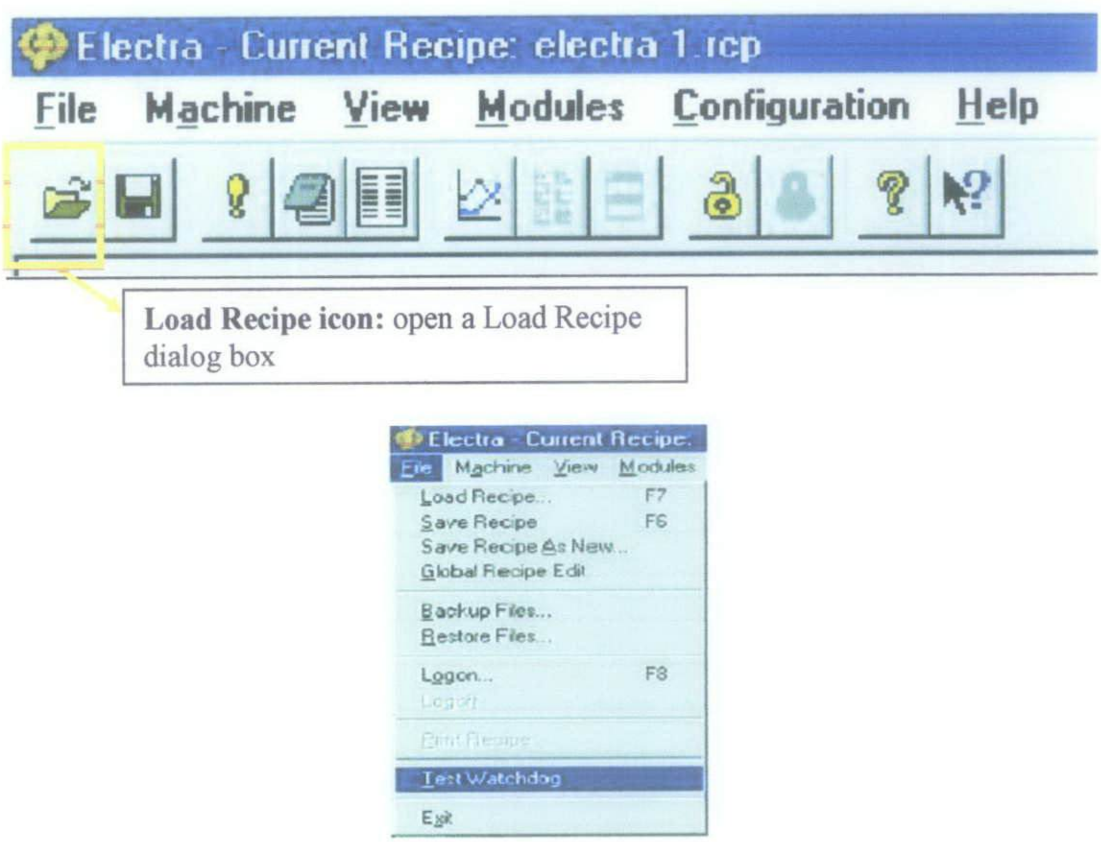


Figure 13: Logon dialog box

2. Load or open the recipe by using Load Recipe Function to load an existing recipe into the system.



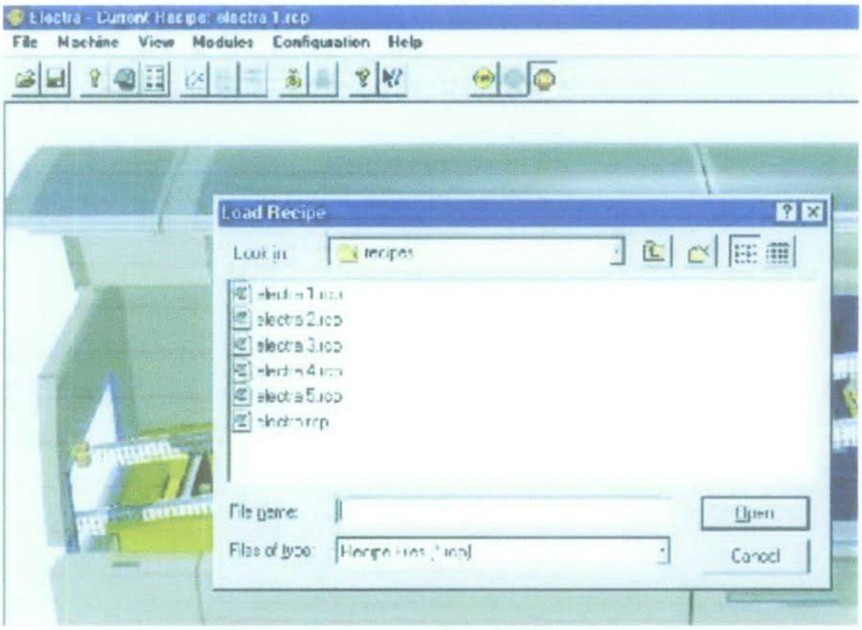


Figure 14 : example of dialog box

3. Then, after open a recipe from existing file, a recipe setting will appear. Here, the technician will set all the require parameter based on PI. All 3 zones; Flux zone, Preheating zone, and Soldering Zone should be **turning on** before set the parameter setting.

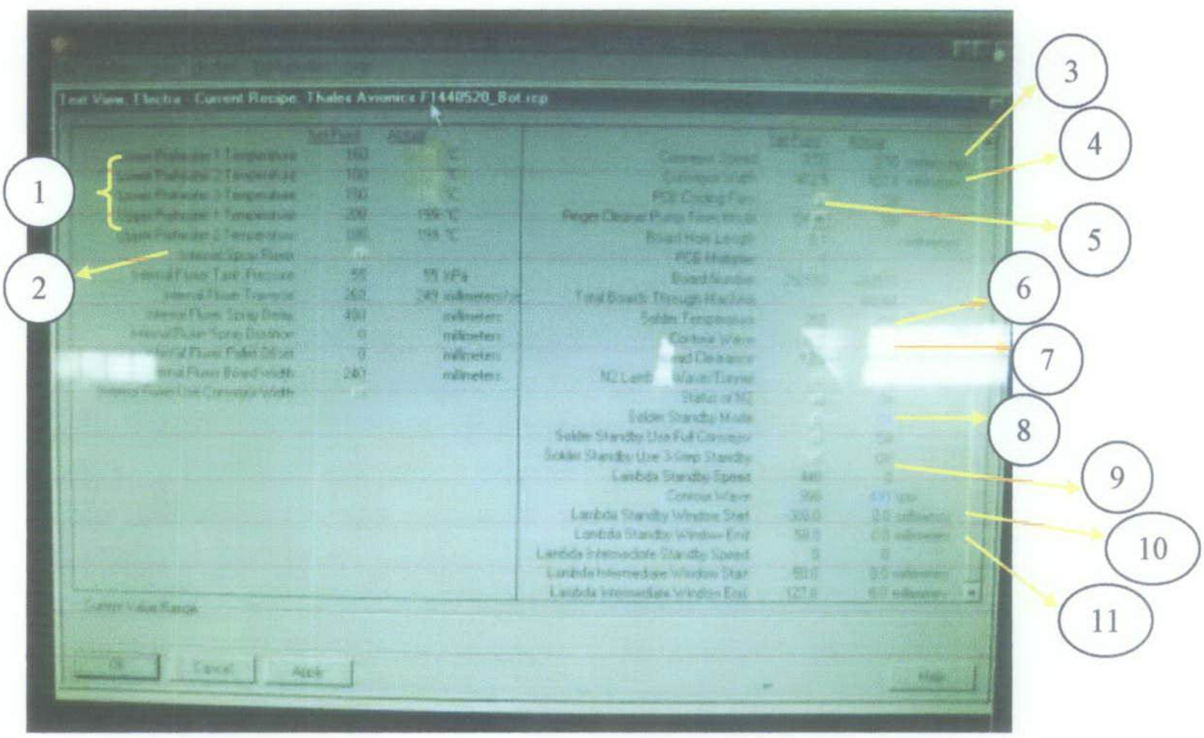


Figure 15 : Example of Recipe Setting

1. *For lower and upper Preheater Temperature, the technician will set the parameter according to the PI.*
2. *For internal spray fluxer, it should be turn ON since Thales Avionics is using Spray flux for their wave soldering process.*
3. *For conveyer speed, the setting also needs refer to the PI. The purpose of this speed is to set up the conveyer to bring in the board into the machine.*
4. *Conveyer width is already done set for every wave solder machine. Basically, this width will not change for every model because of the design of wave pallet itself. It will ensure the wave pallet suit into the conveyer and not fall.*
5. *PCB Cooling Fan: It should be turn on. The purpose of this cooling fan is to cool down the board after it done soldering process.*
6. *Solder Temperature: Basically, the temperature should be in the range of 240°C ~260°C.*
7. Lead Clearance: The purpose for this lead clearance is to ensure the solder reach the finger. It will ensure the solder will reach to the PTH component.
8. *Solder Standby Mode: when it turns on, the solder pot is in standby mode.*
9. *Lambda Standby Speed: For this case, the lambda wave speed in standby mode before the speed reach the setting speed parameter. It will depend on the Lambda Standby Window Start and Lambda Standby Window End.*
10. *Lambda Standby Window Start: Here, the Lambda Wave will start run when the board is in the distance given. It will set in millimeters from lambda wave.*
11. *Lambda Standby Window End: Here, the Lambda wave will turn into standby mode again after the board when to set distance after it done soldering process. It also set in millimeters form Lambda wave.*

4. After finish setting the parameter, the board will load into the machine. If there is any defect after wave soldering, the technician will redo the setting for getting the actual parameter for wave soldering.