Improvement Of Drop Component and PCB Warping for PCBA PFU SMT Process Optimization

Final Project

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Attestation Sheet

The Final Project Proposal is prepared to be used as a work plan for the implementation of the Final Project

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IMPROVEMENT OF DROP COMPONENT AND PCB WARPING FOR PCBA PFU SMT PROCESS OPTIMIZATION

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Abstract

This study addresses the optimization of the Printed Circuit Board Assembly (PCBA) process, specifically focusing on resolving issues related to drop components and PCB warping during the Surface Mount Technology (SMT) process at PT. SIIX Electronics Indonesia. The primary problem identified was the high rate of defects in the PCBA process for the PFU model, which significantly impacted production efficiency and quality. To tackle these issues, a comprehensive literature study was conducted, followed by data collection and observation. The proposed solution involved two main strategies: the application of ADE420D epoxy to minimize drop components and the installation of stiffeners to reduce PCB warping. The testing and optimization process followed a rigorous design methodology, iterating through test designs and repair testing to ensure effectiveness. The results after implementing these optimizations were promising. The occurrence of drop component defects decreased by 94%, and PCB warping defects were reduced by 84%. These improvements indicate a significant enhancement in the overall PCBA process quality, although further optimization is needed to achieve the target of zero defects.

Keywords: PCBA, SMT, Drop Component, PCB Warping

1. Introduction

An electronic product has a very important module in it, namely the Printed Circuit Board (PCB) which aims to run the electronic product. PT SIIX Electronics Indonesia is one of the companies that stands in the field of electronics manufacturing Printed Circuit Board Assembly (PCBA). This company has worked on many projects, one of which is the PCB project for the PFU model, namely the PCB used for the camera machine. However, a production must have problems or obstacles faced either from the process, machine, manpower or material. When the author followed the PFU project during the internship, some problems occurred when the company was producing this PFU PCBA during the SMT process.

Surface Mount Technology (SMT) is a technology used to attach electronic components to the surface of a PCB. While electronic components that can be paired by SMT machines are called Surface Mount Devices (SMD) [1]. From the report or PCBA PFU defect data in the SMT process in 2022 at PT. SIIX Electronics Indonesia, it still looks like there are quite a lot of PCB Warping and Drop Component defects on the PCB.

Based on the results of discussions with the industry conducted by the author to the supervisor of the company holding the project, there are still defects or damage that occur in the production process and the author optimizes the two types of defects. With this, the author raises the title DROP COMPONENT AND PCB WARPING REPAIR FOR OPTIMIZATION OF PFU PCBA SMT PROCESSES.

2. Literature Review

A. PCB (Printed Circuit Board) dan PCBA (Printed Circuit Board Assembly)

Printed Circuit Board (PCB) or printed circuit board is an electrically conductive circuit or electronic circuit path of conductive material, such as copper, which is produced on a printed circuit board or printed circuit board to make connections between electronic components [1]. Printed Circuit Board (PCB) or printed circuit board is a board used to install SMD (Surface Mount Device) components and through hole components, where the connecting path uses a copper-coated board. To form the connecting line, etching is done, which is where the copper is chemically released from the empty copper-coated board. *Meanwhile*, Printed Circuit Board Assembly (PCBA) is a PCB that has installed SMD and through hole electronic components.

B. *Defect Type*

1) *Drop Component*

Drop Component is one of the defects that occurs on PCBs where components mounted during the SMT process fall (Drop) when moving from the bottom process to the top side while in the reflow machine.

2) *PCB Warping*

Is one type of defect that occurs on PCBs, where the PCB is bent, usually the factor that affects this is the PCB fiber that is too thin or the temperature on the SMT machine.

C. *SMT (Surface Mount Technology)*

1) *Definition of SMT*

Surface Mount Technology (SMT) is a technology used to attach electronic components to the surface of the PCB. Electronic components that can be mounted by SMT machines are called Surface Mount Device (SMD) [2].

With SMT technology, electronic equipment or gadgets can now be designed with a smaller size, this is because SMT machines can pair very small chip components up to 0.4mm X 0.2mm (Chip SMD resistor with metric code 0402) with a very highspeed reaching 136,000 components per hour or about 2,266 components per minute [2].

2) *SMT Configuration*

The SMT product configuration depends on the type of product to be produced, including SMT processes that use adhesive bonding and SMT processes that use solder paste bonding, or combined SMT processes.

D. *Seven Tools (7 QC Tools)*

Statistically, quality control can use SPC (Statistical Process Control) which has 7 main statistical tools or can be called seven QC tools as a tool to controlproduct quality including: Check Sheet, histogram, control chart, pareto diagram, fish bone diagram, scatter diagram and process diagram.

Here the author will use a check sheet and histogram to control product quality.

1) Check Sheet

A Check Sheet or inspection sheet is a tool for collecting and analyzing data presented in table form. This table records the number of items produced as well as the type and quantity of product nonconformities found [3].

Motor Assembly Check Sheet

Name of Data Recorder: Lester B. Rapp
Location: Rochester, New York
Data Collection Dates: 1/17 - 1/23

Defect Types/ Event Occurrence	Dates							TOTAL
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
Supplied parts rusted		|||||||	|||||	||||	||			20
Misaligned weld			|||			||	5
Improper test procedure								0
Wrong part issued								3
Film on parts								0
Voids in casting				||||	||		6
Incorrect dimensions						||	2
Adhesive failure								0
Masking insufficient								1
Spray failure			|||||				5
TOTAL		10	13	10	5	4		

Figure 1. Illustration of Check Sheet

2) Histogram

Histogram is a graphical representation of frequency distribution. This histogram is created with class intervals displayed on the horizontal axis, while the class frequencies are displayed on the vertical axis. Each bar in the histogram extends from the base of the same class interval, with the height of the bar determined by the corresponding class frequency [4].

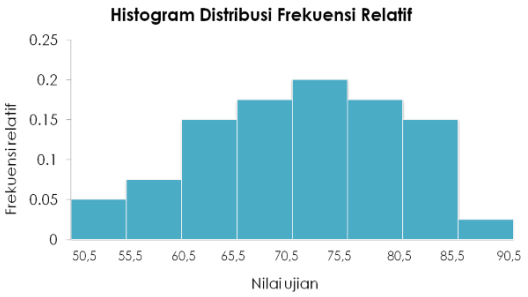

Figure 2. Illustration of Histogram

3. Methods

A. Design

The test method in this system design is as follows:

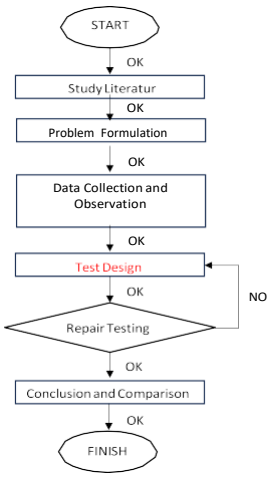

Figure 3. Testing Flow Chart

The process starts with conducting a literature study to understand the topic of research. Based on the literature study, the problem is formulated and followed by data collection and observation related to the formulated problem. Next, a test design is created based on the collected data and observations. If the testdesign is not successful, repair testing is conducted and the test design process is repeated. Once the test design is successful, the results are compiled into conclusions and comparisons

B. SMT Process Design at Optimization

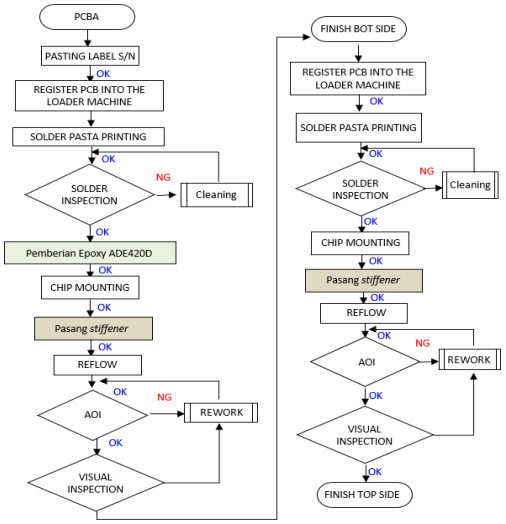

Figure 4. SMT process flow chart during optimization

The PCB assembly and inspection process begins with attaching the serial number label to the PCB. Next, the PCB is registered into the loader machine, and solder paste is printed onto the PCB. After the solder paste is printed, a solder inspection is conducted. If the solder inspection results are good, the process continues; otherwise, cleaning is performed before reprinting the solder paste.

After passing the solder inspection, epoxy ADE420D is applied to the PCB, followed by chip mounting. If needed, a stiffener is installed, and then the PCB undergoes the reflow process. The reflowed PCB is inspected using Automated Optical Inspection (AOI). If the AOI results are good, the process proceeds to visual inspection. However, if the AOI results are not good, rework is performed before returning to AOI.

Subsequently, a visual inspection is conducted on the PCB. If the visual inspection results are good, the bottom side process of the PCB is completed. If not, rework is performed. After finishing the bottom side, the PCB is registered again into the loader machine to start the process on the top side. Solder paste is printed on the top side of the PCB and inspected through a solder inspection.

C. Optimization Design

1) Test 1 (Issue Drop component)

a) Before Optimization

This product defect occurs due to a drop component so that it becomes a missing component at location T351 during the SMT process transfer from bottom side to top side due to the body component being too large and the component leg bending size is too small and the lead component size is larger than the PCB pad design.

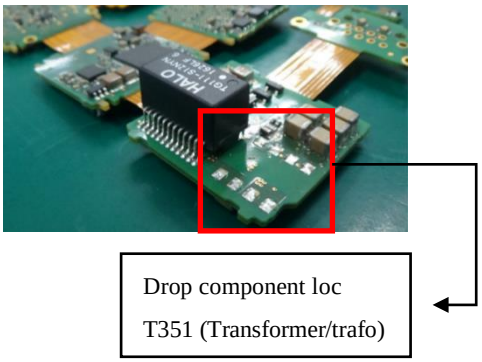

Figure 5. NG Drop component in the red box

b) Optimization

The author's optimization is that after the PCB PFU comes out of the solder paste inspection process, there is an additional process of giving epoxy using a Musashi machine first which aims to hold the T351 (Transformer) component so that there is

no drop that causes missing components When the process of moving from top side to bottom side on SMT

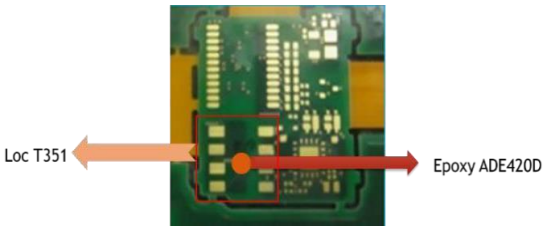

Figure 6. Illustration of epoxy application

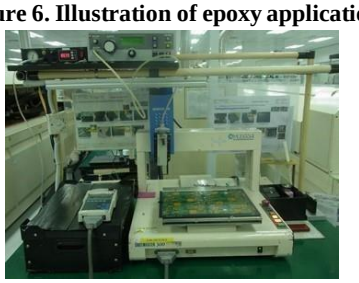

Figure 7. Epoxy dispensing machine

2) Test 2 (Issue PCB Warping)

a) Before Optimization

This defect is caused by high temperatures, causing the fibers on the PCB to not be bound, and opening breaking (Dummy PCB) which is too small.

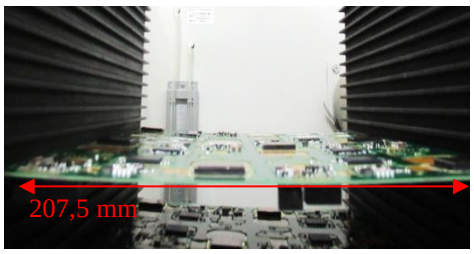

Figure 8. NG PCB Warping not using stiffener

In Figure 8 is a PCB Warping defect, because the length of the PCB is warped and out of tolerance. The limit of the specified tolerance is not less and more than 0.20 mm, while the length of the from figure 8 is 207.5 mm which should be 208 mm for an ok PCB.

b) Optimization

The author's optimization is that before the PFU PCB enters the reflow process, there is an additional stiffener installation process on the 2 sides of the PCB to prevent warping of the PCB when entering the reflow machine.

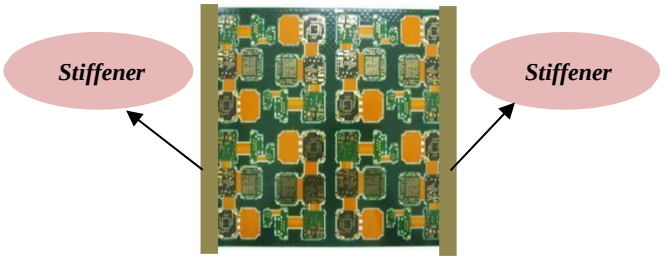

Figure 9. Illustration of stiffener addition

4. Results and Discussion

A. Test 1 (Issue Drop Component)

The way to overcome the drop component defect is by applying epoxy to the location of components that often drop by paying attention to certain specifications.

1) Previous Process

No epoxy bonding is applied before the PCB enters the reflow machine.

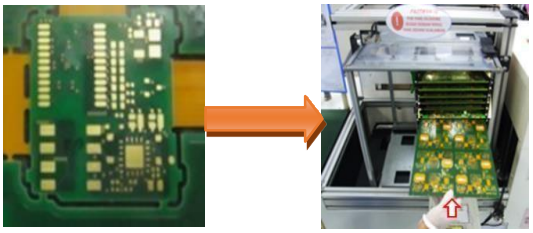

Figure 10. Process from bare PCB directly to SMT process without addition of epoxy

2) New process (Optimization)

a) ADE420D Epoxy Preparation

Using ADE420D epoxy with attached datasheet.

Figure 11. Epoxy ADE420D

b) Setup Epoxy to Musashi machine and Apply Epoxy to PCBA after printing solder paste

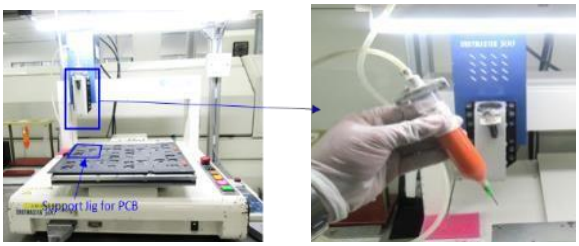

Figure 12. Bonding machine for epoxy application and setup epoxy to the machine

Figure 13. Machine nozzle during epoxy bonding

c) Epoxy bonding result

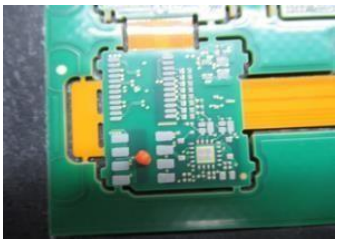

Figure 14. Top view of epoxy bonding result

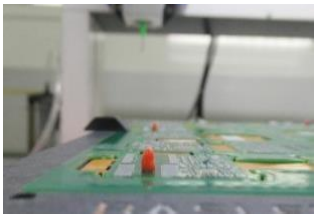

Figure 15. Side view of epoxy bonding

Figure 14 shows the results of epoxy bonding from the top view, while Figure 15 shows the results of epoxy bonding from the side view.

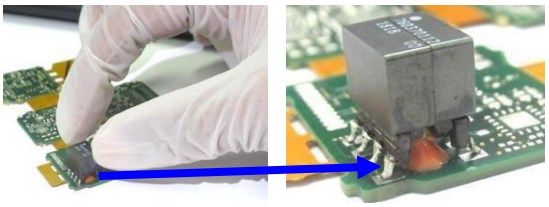

Figure 16. Manual Placement

In Figure 16, the T351 component is manually installed to the location that has been paired with epoxy, and the epoxy touches the body component.

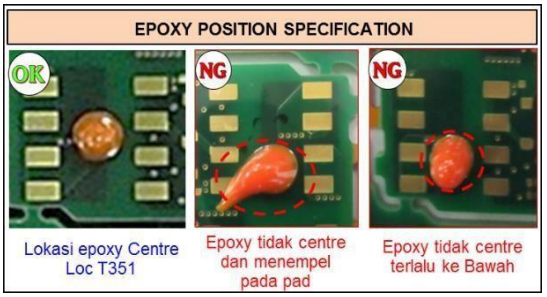

Figure 17. Epoxy position specification

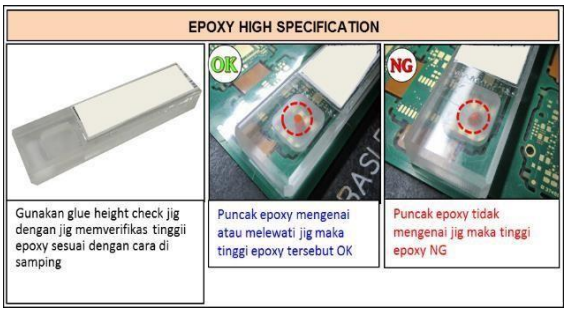

Figure 18. Epoxy high specification

Figure 17 explains the position of the epoxy in accordance with the applied specifications, for the correct epoxy position is in the center of the T351 component installation location. While Figure 18 describes the height specification of the epoxy which is 0.35 mm.

d) Enter The First Reflow Machine (Bottom Side)

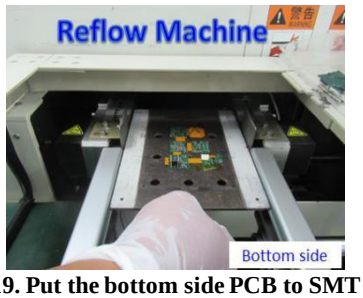

Figure 19. Put the bottom side PCB to SMT pallet

Put the PCB bottom side into SMT pallet then put the PCB into reflow machine

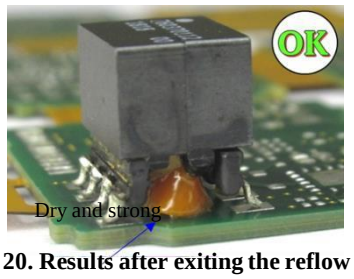

Figure 20. Results after exiting the reflow machine

Can be seen from Figure 13 is theresult of epoxy and T351 components after coming out of the reflow machine, theresults of the epoxy are dry and strong.

e) Enter The Second Reflow Machine (Top Side)

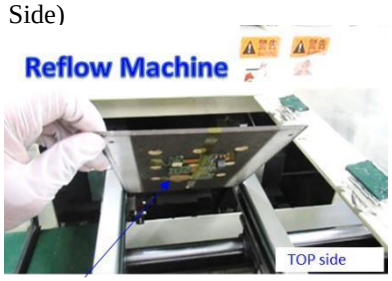

Figure 21. Put the top side PCB to SMT pallet

Place the PCB on the SMT pallet, then reverse the pallet position and put the PCB into the reflow machine.

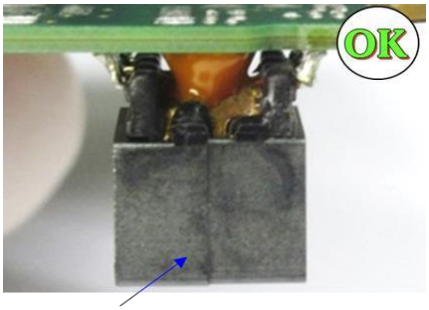

Figure 12. Components after exiting reflow machine

It can be seen in Figure 22 that the component does not fall after leaving the reflow machine.

a) Results After Optimization

Figure 23. Component installation results using

Figure 23 shows the side view of the epoxy and T351 components.

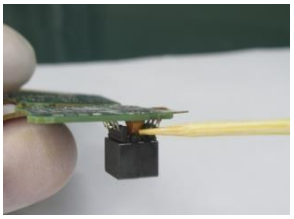

Figure24. Epoxy strength testing

Figure 24 shows the epoxy strengthtest with component T351, the picture shows no drop component.

B. Test 2 (Issue PCB Warping)

The way to overcome the PCB Warping defect is by installing a stiffener on the PCB before entering the reflow machine. To reduce the occurrence of PCB Warping, the author intends to test the process of adding a stiffener tool to 5 PCB sample panels with the same thickness.

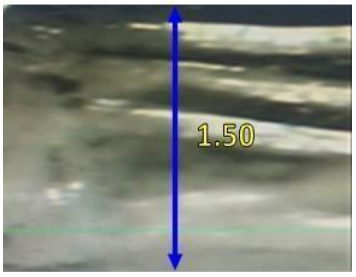

Figure 25. Sample 1

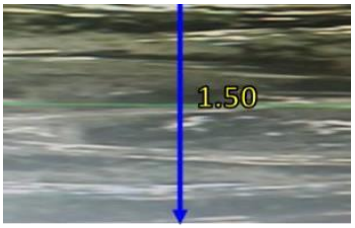

Figure 26. Sample 2

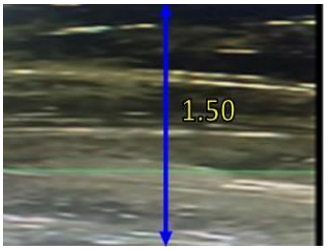

Figure 27. Sample 3

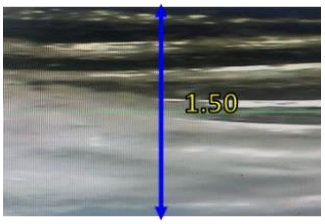

Figure 28. Sample 4

Figure 29. Sample 5

The purpose of taking the same PCB thickness is to proceed to the stiffener manufacturing process which requires the thickness of the PCB.

1) Previous Process

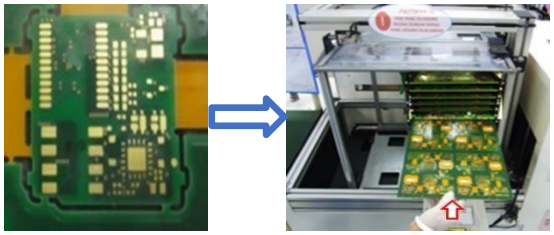

Figure 30. Add bare PCB directly to SMT process

Figure 30 shows the process of putting the bare PCB directly into the SMT process without the addition of stiffeners.

2) New Process (Optimization)

a) Prepare The Stiffener

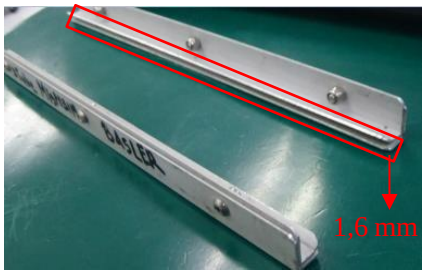

Figure 31. The stiffener

Prepare the stiffener before proceeding to the next process

Description:

Size of stiffener= P = 208 mm

L = 1.6 mm

Material= Aluminum

b) Installation of the stiffener tool before the PCB enters the reflow machine

Figure 32. Stiffener installation specifications

After stiffener installation, the PCB is ready to enter the reflow machine.

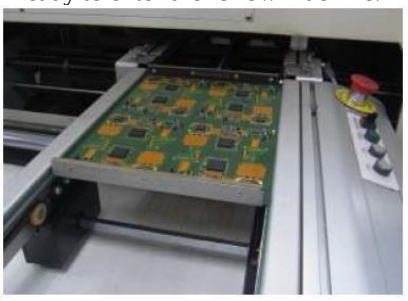

Figure 33. Add PCB to reflow machine

c) Result after optimization (Improvement)

Figure 34. Result sample 1

Figure 35. Result sample 2

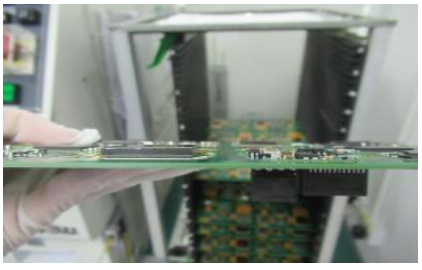

Figure 36. Result sample 3

Figure 37. Result sample 4

Figure 38. Result sample 5

C. Comparison data before and after Optimization

The following is statistical data from the comparison of the quantity of drop components and PCB warping before and after improvement or optimization. Comparison with implementation during 3 months of the PFU project

1) Drop Component

Table 1. Drop component testing results

No	Action	Month			Total Deffect	Total Qty Running for 3 Month
		Augustus	September	October		
1	Before Opmization	22	22	23	67	540
2	After Optimization	2	1	1	4	540

Above is the table before and after optimization of the drop component that was experimented for 3 months. It can be seen from the results of improvement / optimization that the defect on the component drop has decreased very much. There are still 1 or 2 defects left on the component drop after optimization, because the volume of the epoxy is insufficient and does not reach the part of the component body to be installed, so that the epoxy is not attached to the component body and the component drops after leaving the reflow machine.

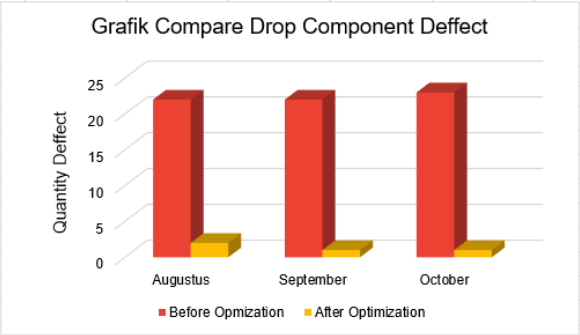

Figure 39. Graphics compare drop component defect

Percentage Success pf Improvement

$$= \frac{(Beginning - End)}{Beginning} \times 100\%$$

$$= \frac{(67-4)}{67} \times 100\%$$

$$= 94\%$$

2) PCB Warping

Table 2. PCB Warping testing result

No	Action	Month			Total Deffect	Total Qty Running for 3 Month
		Augustus	September	October		
1	Before Opmization	9	5	5	19	540
2	After Optimization	1	1	1	3	540

The above is a table of before and after optimization against PCB warping that was tested for 3 months. It can be seen from the results of improvement / optimization that the defect on the PBC warping has decreased very much. There are still 1 or 2 defects left on the warping PCB after optimization, because the PCB in the middle has no holder and the temperature is too hot/high.

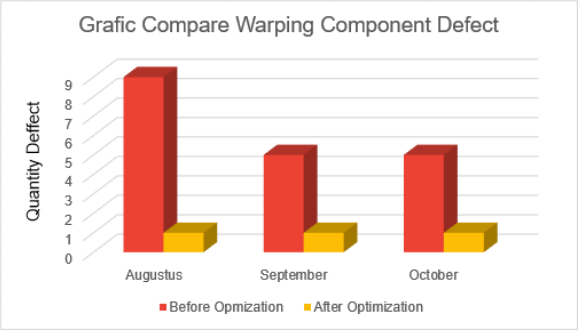

Figure 40. Graphics compare PCB Warping defect

Percentage Success of Improvement

$$= \frac{(Beginning - End)}{Beginning} \times 100\%$$

$$= \frac{(19-3)}{19} \times 100\%$$

$$= 84\%$$

Conclusions and Suggestions

A. Conclusion

Based on the results and discussion, it can be concluded that the optimization of PCBA PFU SMT process through the improvement of drop components and PCB warping is as follows:

1) Optimization of drop components through the addition of ADE420D epoxy is not optimal but to minimize the occurrence of drop components this method can still be used. Because, based on the compared Drop Component defect graph, the defect quantity has decreased to 94% from the target of 100% no defects found.

2) Optimization of PCB Warping through the installation of stiffeners is not optimal, however, to minimize the occurrence of PCB Warping this method can still be used. Because, based on the PCB Warping defect comparison chart, the defect quantity has decreased to 84% from the target of 100% no defects found.

B. Suggestion

For the next optimization of drop components and PCB Warping, to further develop the optimization carried out to achieve 100% no defect found results.

References

Below are the references I used for work on this project

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