Solder Spatter Defect Analysis

Final Project

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2025

STATEMENT OF AUTHENTICITY OF FINAL PROJECT

I, the undersigned, certify that the contents of part or all of my Final Project entitled: " Solder Spatter Defect Analysis " is my own work, completed without the use of materials that are not permitted , and is not the work of other parties which I acknowledge as my own work. All references cited or referred to have been written in full in the bibliography. If it turns out that my statement is not true, I am willing to accept sanctions in accordance with applicable regulations..

Cegléd, 9 January 2025

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APPROVAL

The Final Project was prepared to fulfill one of the requirements to obtain the degree of Associate Expert in Engineering (AMd.T.)

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Solder Spatter Defect Analysis

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***Abstract*— The soldering system process is a soldering process where chip components are melted by high temperature hot air to form a reflow temperature change process, thus forming a module which is then cooled together. During the soldering process, some scrap often occurs, one of which is solder spatter. The aim of this final assignment is to analyze how often solder spatter occurs on products. In this research I used the flow chart, data collection to determine how many scrap solder spatters are in the soldering system process.**

Keywords: ***system soldering, scrap, solder spatter***

I. INTRODUCTION

Infineon is a company operating in the semiconductor sector. Infineon's main products are integrated circuits in several fields, namely computer memory (DRAM, flash memory), communications (babel and non-wire), automotive and industrial applications **Error! Reference source not found.**. The production process uses very complex equipment and is integrated with IoT standards so that the products the company produces are very good. There are several processes in making modules, one of which is the soldering system process, the soldering system, the DCB placement process. In the system soldering process there are many things we have to pay attention to, namely carrying out the work in accordance with standard operating procedures, whether the soldering results comply with standards such as seeing whether there are scratches on the module[2]. base plate or there are solder splashes on the DCB and make sure there are no broken DCBs, make sure there are no defects in the product and the DCB is installed correctly according to the picture to avoid failure.

This is because during the soldering process many products do not meet standards or products fail because they do not follow standard work requirements, so several defects occur, one of which is solder spatter[3].

II. METHOD

Design of the Research Design of the Research

The test method in designing this system is as follows:

1. Study literature
2. Collect data
3. Analysis data
4. Analysis problem
5. Action and monitoring
6. Implementasi
7. Result and conclusion

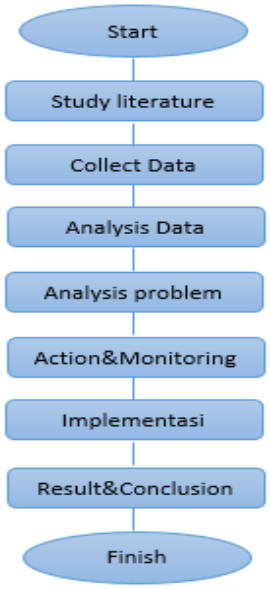

Figure 1. Flowchart of test design

The first step is to study the literature to find out information related to the data you want to analyze. Then we collect the data so that we obtain actual data for analysis. In data analysis we select products that are defective or not. After that, what actions and implementation should be taken to prevent product defects, using methods and materials that comply with the provisions, following work instructions correctly, checking each product after soldering. Finally, we can draw the results and conclusions.

A. Method Research

The method used by researchers is a qualitative method by analyzing problems and describing what happens in the internship workplace[4].
The things I did with this method were:

- Observation, I identify and make some notes on the things I observe.
- Interview, ask colleagues several questions about the soldering system process and what causes solder spatter defects on the product.

B. System Soldering

The SMD soldering process in a Reflow Oven is also called reflowing soldering, where the solder pad changes from solid to liquid at high heating temperatures to create a permanent solder connection between the DCB and the base plate, then cools so that the shape returns to a solid form [5]. The main concern with the reflow soldering process is the quality of the solder joint. Precise control of the temperature profile and soldering time to avoid defects in the product[6].

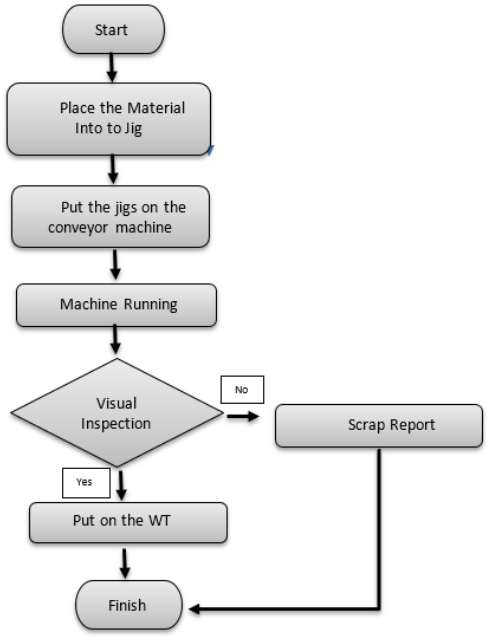

Figure 2. Flowchart System Soldering Process

Manufacturing step make a product :

1. **Start,** prepare the necessary materials and equipment such as soldering jig, vacuum, DCB, solder pad, base plate, and others on the .
2. **Place the materia into to jigs,** place the DCB into the solder printing jig, then on the second layer of DCB, place the solder pad, then cover it using the base plate.
3. **Put the jigs on the conveyor machine,** then after arranging the material into the jig, place the jig on top of the frame in the soldering machine correctly.Then we wait for the soldering results for around 17-20 minutes. This machine can accommodate 4 forma in it.
4. **Visual inspection,** when we are ready for soldering, we lift the printing jig then place it on the rubber sheet, then we do a visual inspection with our eyes on the product to see if there are any defects in the product such as solder spatter defects and if the result are not standard then it will be scanned for scrap.
5. **Put on the WT,** each modle that has completed the soldering stage must be placed on the WT.
6. **Finish,** the good module quality products will be delivered to the next process.
7. **Continue to Rontgen Process,** if the module has a good.

Fishbone Diagram

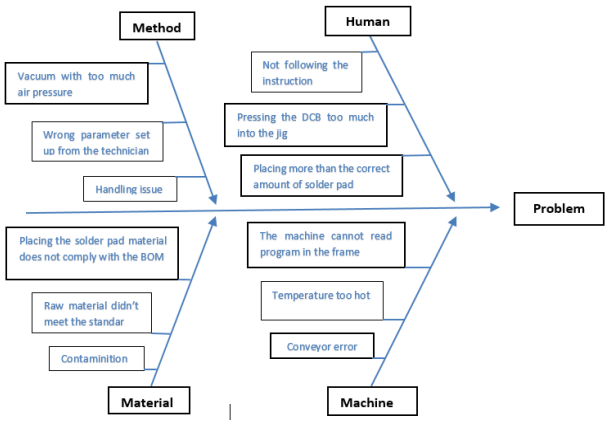

Figure 3. Fishbone Diagram

Tabel Potensial Problem

Factor	Problem	Verification	Remark	Action Taken
MACHINE	Conveyor error	Check the machine monitor and physically check the conveyor	Conveyor rubber breaks due to excessive friction	Replace conveyor rubber and scheduled maintenance
	Temperature too hot	Check the temperature sensor and cooling system	Overheating can damage components	Change program
	The machine cannot read program in the frame	Check the program file and communication settings	Incorrect program or communication error	Re- upload the correct program
MAN	Not following the instruction	Observe operator's work and review training records	Lack of training or misunderstanding	Must follow standard work intructions
	Pressing the DCB too much into the jig	Measure the force applied and check the jig alignment	Excessive force can damage components	Adjust the jig and provide force guidelines
	Placing more than the correct amount of solder pad	Make sure to place only one solder pad	Placing more than one solder spatermay cause solder spatter	Pay close attention when placing only one solder pad
MATERIAL	Placing the solder pad material does not comply with the BOM	Compare the material specification with the BOM	Incorrect material used	Ensure the correct material is used
	Raw material didn't meet the standar	Conduct quality inspection on incoming materials	Defective materials can cause product failure	Check the expiration date of the ingredients again
	Contamination	Pay attention to the condition of the jig	Dirty jigs can cause module contamination	Make sure the jig and material are clean
METHOD	Vacuum with too much air pressure	Measure the vacuum pressure	Excessive vacuum can damage components	Adjust vacuum pressure
	Wrong parameter set up from the technician	Review the setup procedure and parameter settings	Incorrect settings can cause process failures	Create a standard operating procedure
	Handling issue	Observe handling procedures	Rough handling can damage components	Implement proper handling prosedures

C. Tools and Material

Material and tools needed for the soldering system process :

- Jigs, is used to place the module, solder pat, and base plate on its surface.
- Vakum, this vacum is used to take single module, solder pad, and NTC.
- Flip Tray, this is used to invert the tray on top of which is DCB.
- WT, is a transit point for module to the transferred to the next process.
- Rubber sheet, this is the place to put the module after soldering by the machine.
- Nuttzen or DCB, this is a single module that will be soldered on a machine that can also be called Nuttzen.
- Solder pad, is a thin swath copper pad used to connect electronic components.
- Base plate, which will be the base on the module to be soldering.
- Sticker, to mark WT with charge number.

III. RESULT AND DISCUSSION

Solder spatter is unclean splashes of flux from solder paste during the reflow soldering process. flux residue sticks to the test pads and makes testing within the circuit difficult. Residue can act as an obstacle that prevents in-circuit probe contact with the test pads, and, as a result, the tester automatically marks the board as scrapped even if the board is fully functional. Furthermore, flux residue contaminates the pads that serve as connectors and can deteriorate electrical contacts.

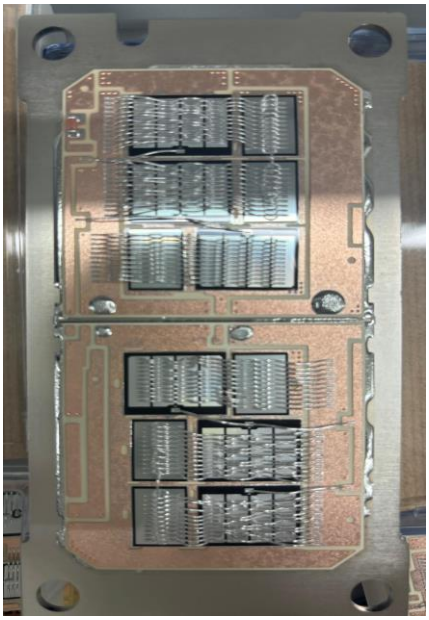

Figure 5. Scrap of solder spatter

In this case the author found a result of the solder spatter defect. In general, this defect occurs because the operator is not careful and is caused by errors in jig assembly and even material errors in the base material and also because of the machine.

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A. Result of human error

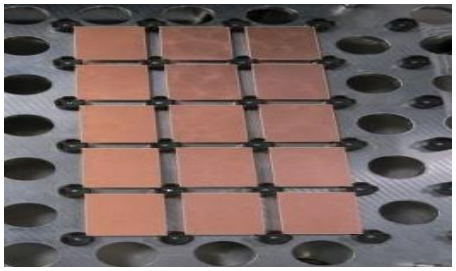

Figure 6. Laying Nutzen

errors caused by the operator because they do not pay attention to the picture and do not pay attention to the direction of the nutzen as shown in the picture, the Nutzen can only be placed on the solder mold with a vacuum clamp.

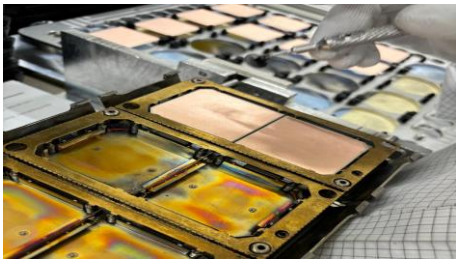

Figure 7. Placing to much Plessure on the Nuttzen

an error caused by the operator by pressing the DCB too much into the jig so that the surface of the DCB is uneven and

causes a cavity in the jig so that during the soldering process the solder pad can rise above the surface of the DCB.

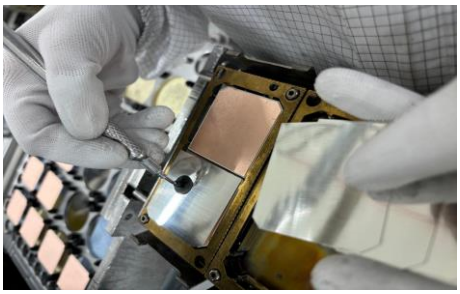

Figure 8. Placing 2 Solder Pad

an error caused by the operator by placing 2 solder pads onto the layer module and causing excess solder which could splash solder liquid onto the DCB.

B. Result of Jig Assembly

Figure 9. Jig Dual

The soldering jig is a place to place the DCB module, there are many types of jigs such as dual Econo, Pack+B, Pack+D, Pim 2, Dual, Steck 3, Steck 2, and Econo 3. This jig will be the cover and place for the soldering process, This stage is a process that requires precision and accuracy in placing the DCB, if you insert the DCB unevenly on the surface of the jig then the results that come out will not be good and will result in errors in the soldering iron, and will generate an error code.

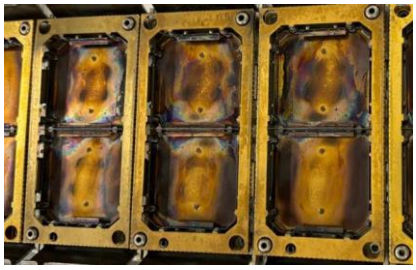

Figure 10. Broken Jig

In this case, the condition of the jig is not good because the solder splash leak prevention part is bent and causes a cavity in the jig. This will cause the results on the module to be imperfect and will result in the module having solder splashes. To avoid this, the operator must do a visual first.

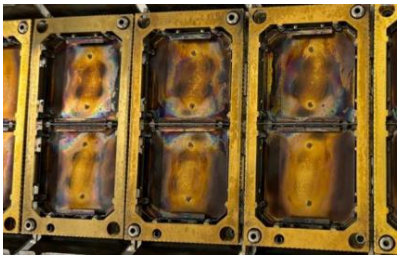

Figure 11. Contamination Jig

If the jig is contaminated by dirt or solder residue during the process, it will cause the solder to remain on the surface of the DCB, therefore before using it, make sure the jig is clean and before using it, the jig must be hit on the support so that there is not solder residue lef on the jig

C. Result of Machine

Figure 12. Machine Soldering System

Soldering process, where this process is soldering the DCB part and the solder pad then the baseplate, in this process of course there are many tools used in the module soldering process, namely by inserting the DCB module into the jig. The placement of the DCB module is of course very important in the soldering technique, because if the DCB module is not placed on the surface evenly, of course the soldering results will not be optimal. After everything is finished, the jig will be inserted into the mold and the mold will be loaded into the machine conveyor.

Figure 13. SPC Heat Program

1. In this case, errors in the machine are also something that must be considered, namely when the operator forgets to enter the Fauf program number on the machine, the form conveyor does not function.

2. Damage to the module is also caused by unstable temperatures in the engine. A good heat for melting solder in the first room is a temperature below 240°C for 3 minutes 12 seconds. and room 2 with a temperature of 330°C for 3 minutes 45 seconds, heat the entire part by joining the base plate on the solder pad and nutzen. and the third room with a temperature of 21°C for 2 minutes 19 seconds and the last room is module cooling, which is for 220 seconds, this is of course the center of attention because if there is a problem with the conveyor and the jig does not move at the time it should, then the jig will stop Staying in room 2 for too long can cause excessive solder overflow and solder splashes can occur on top of the DCB.

3. The module results were not good because the leak test fluid in the engine was not replaced every replacement date. Usually the maintenance officer will check the leak test fluid and if it is not replaced then the machine will not function properly. What often happens is that the module is not soldered or the color of the soldering is not up to standard.

4. If the conveyor gets stuck on the way and stops in the chamber and causes the baking time on the module to not match the time it should, it will cause solder to splash into the surface on the DCB and can also cause the module to burn so that the module also changes color.

D. Data Scrap

I. Scrap data in January - April

No	Type Scrap	Scrap Data in January - April																Total
		January				Febuary				March				April				
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
1	Jig Contamination	7	5	4	2	7	5	3	3	7	5	5	5	7	5	5	3	78
2	Conveyor Error	14	7	5	5	5	7	7	14	3	4	5	6	8	6	4	5	105
3	Temperature too Hot	12	4	5	5	7	7	3	10	3	2	5	5	6	5	3	3	85

Figure 14. Scrap Data in January to April

II. Scrap data in May - August

No	Type Scrap	Scrap Data in May - August																Total
		May				June				July				August				
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
1	Jig Contamination	5	3	3	2	0	3	3	2	3	0	3	2	0	3	3	2	37
2	Conveyor Error	2	1	0	4	3	5	2	2	2	4	5	0	2	1	2	1	36
3	Temperature too Hot	2	2	0	1	3	0	0	0	0	0	2	5	2	3	1	0	21

Figure 15. Scrap Data in May to August

III. Diagram in January - April

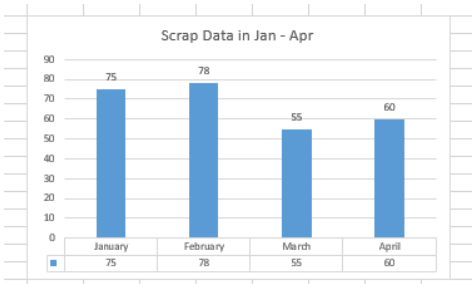

Figure 16. Diagram Scrap Data in January to April

IV. Diagram in May – August

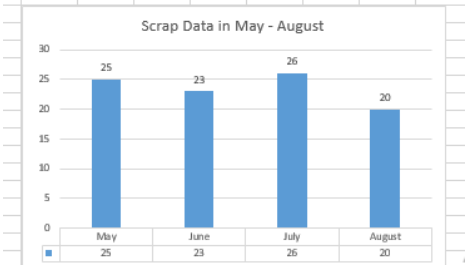

Figure 17. Diagram Scrap Data in May to August

V. Comparative data in four month (January to April) and (May to August)

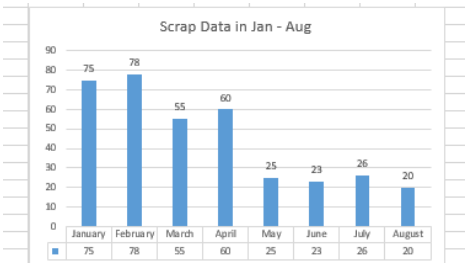

Figure 18. Scrap Before and After Improvement

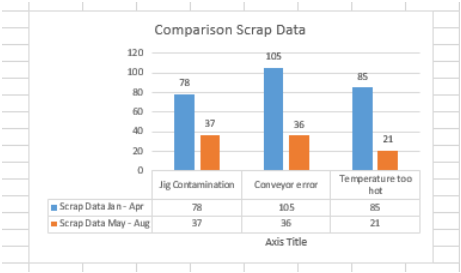

Figure 19. Comparison Diagram

E. Good Module

Products that have gone through the process and succeeded without any damage are products of good quality. This product is designed to withstand daily use and a variety of environments. They are able to carry out their functions well without interference.

Figure 20. Good Module

IV. CONCLUSION

The result of the solder spatter defect analysis have provided insight into the root causes of the observed problems. Through careful testing and observation, several factors causing solder spatter defects are caused by equipment, machine and also less careful operators. Overcoming these factors is by choosing the right material and maintenance jig must be periodic to reduce defects and improve quality with good module standardization and following the steps according to procedures.

V. ACKNOWLEDGMENT

I would like to thank PT Infineon Technologies Cegled, Hungary for giving me the opportunity for the internship program at the company.
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References

[1] AG, I.T (1999-2023). *1*. From Infineon Technologies: https://www.infineon.com/cms/en/about-infineon/background.(n.d)

[2] Peng Sun, "An Overview of Mechanical Characterization for Power Module: Challenges, Advances, and Future Prospects", vol.40, no.3, pp.4112-4130, 2025.

[3] Martin, W., Waibel, B. and Laaser, W. (1990), "Thermal Resistance and Temperature Cycling Endurance of DCB Substrates", Vol. 7 No. 2, pp. 29-33.

[4] POPULIX Data Kuantitatif Adalah: "Pengertian, Jenis, dan Contohnya" Internet:https://info.populix.co/articles/data-kuantitatif-adalah/ 2022 [September 26, 2022]

[5] Jonghwan Ha,"Reliability of Differently Shaped Solder Joints in Chip Resistor Under Drop Impact",pp.1639-1643, 2024.

[6] Yangyang Lai,"The Optimal Solution of Reflow Oven Recipe based on Physics-guided Machine Learning Model", pp.1-6, 2022.

FORMULIR LOOGBOOK BIMBINGAN DAN PENGAJUAN SIDANG TUGAS AKHIR

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No	Hari/Tgl	Rincian Kegiatan	TTD Pembimbing	
1	Kamis, 14/9/2023	Pengajuan judul proposal		
2	Selasa, 10/10/2023	Melakukan zoom, membahas tentang pembuatan proposal		
3	Rabu, 6/12/2023	Melakukan bimbingan bab ,I,II,III, dan IV		
4	Senin, 11/12/2023	Melakukan bimbingan bab ,I,II,III, dan IV		
5	Selasa, 26/11/2024	Revisi laporan progress pengerjaan Tugas Akhir		
6	Selasa, 10/12/2024	Revisi laporan progress pengerjaan Tugas Akhir		
7	Jum’at, 03/01/2025	Revisi laporan progress pengerjaan Tugas Akhir		
8	Rabu, 08/01/2025	Revisi laporan progress pengerjaan Tugas Akhir dan mengajukan F-II		
9				
10				

Berdasarkan hasil bimbingan yang telah dilaksanakan selama 3 bulan dan telah disetujui oleh dosen pembimbing, maka dengan ini saya mengajukan diri sebagai peserta sidang tugas akhir .

Hungaria, 09 Januari 2025
Peserta

Alisa Rahmawati
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FORMULIR LOOGBOOK BIMBINGAN DAN PENGAJUAN SEMINAR PROPOSAL

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Berdasarkan hasil bimbingan yang telah dilaksanakan selama 3 bulan dan telah disetujui oleh dosen pembimbing, maka dengan ini saya mengajukan diri sebagai peserta Seminar Proposal .

Hungaria, 11 Desember 2023
Peserta

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