# Development and Implementation of an Automated Uncoated Area Control Parameter to Improve Chemical Efficiency in the PCB Conformal Coating Process

**Final Project**

**By:**
**Ilham Hadinata (3222111022)**

**Electronics Manufacturing Engineering Study Program**
**Electrical Engineering Department**
**Politeknik Negeri Batam**
**2025**

# Statement of Authenticity of Final Project

I, the undersigned, certify that the contents of part or all of my Final Project entitled: "REDUCING OF PICK-UP ERROR THE MACHINE SURFACE MOUNT TECNOLOGY " 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.

Batam, 09 July 2026


Ilham Hadinata
NIM: 3222111010

# Approval sheet

**The Final Project is structured to fulfill one of the requirements for obtaining a degree**
**Bachelor of Associate Engineer (AMd.T.)**
**in**
**Batam State Polytechnic**

**By:**
**Ilham Hadinata (3222111010)**

**Session date: 12 Dec, 2025**

**Approved by :**

**1. Vivin Octowinandi,S.Tr.T.,M.Sc**
**NIK: 120242**

**1. Prasaja Wikanta,ST,MT**
**NIK:103026**

TTe oleh:

PRASAJA WIKANTA
13 Agustus 2026

Perihal:

Laporan PA Ilham hadinata dengan Nim
3222111022

Hashing:

c18de618bdc8f5132733b451787d1db38f4a8fd63
59cf079da7478b92eb2b611

Verifikasi melalui web https://tte.polibatam.ac.id

**2. Muhammad Salman Al-Faruq**
**S.T.,M.Sc**
**NIK: 126371**

# Development and Implementation of an Automated Uncoated Area Control Parameter to Improve Chemical Efficiency in the PCB Conformal Coating Process

## Abstract

The PCB (Printed Circuit Board) conformal coating process plays a crucial role in protecting electronic components from moisture, corrosion, and environmental contamination. However, conventional coating processes often result in excessive chemical usage due to uncontrolled spraying on areas that do not require coating, such as connectors and test pads, leading to material waste and increased production costs. This research aims to develop and implement an automated uncoated area control parameter to improve the efficiency of chemical usage in the PCB coating process. This study employs an experimental research method by comparing a conventional coating process with a coating process integrated with an uncoated area parameter. A total of 2,000 PCB units were used as samples, consisting of 1,000 units coated using the conventional method and 1,000 units coated using the developed parameter. Data were collected through direct observation, coating thickness measurements, machine data logs, and defect analysis. The results show that the implementation of the uncoated area parameter successfully reduced chemical consumption by approximately 15–20% per production batch. In addition, coating-related defects such as uncoating, uneven coating, insuff coating, and excess coating were reduced from an initial rejection rate of 5–10% to 0%. These results indicate that the developed parameter effectively improves chemical efficiency while maintaining coating quality in accordance with IPC-CC-830 standards. This research demonstrates that the use of an automated uncoated area control parameter can significantly enhance production efficiency, reduce chemical waste, and support cost-effective and environmentally friendly practices in the electronics manufacturing industry.

Keywords: PCB, Conformal Coating, Chemical Efficiency, Uncoated Area, Automation Parameter.

# Foreword

Praise and gratitude to Allah SWT, for His grace and blessings, enabling the author to complete the research for this final project report in the 6th semester. This research was conducted as part of the final project report, which is one of the requirements for graduation from the Diploma III Program in the Electrical Engineering Department, Manufacturing Electronics Study Program at Politeknik Negeri Batam.

In preparing this final project report entitled "Reducing of Pick-Up Error on the Machine Surface Mount Technology", The author would like to express deep gratitude to all parties who have provided support, guidance, and assistance throughout the research and preparation of this report. Without their help, this report would not have been completed successfully. Therefore, the writer would like to extend sincere appreciation to :

1. My beloved parents and family, for their constant moral and financial support from my childhood to the present.
2. Mr. Ir. Bambang Hendrawan, ST., MSM., CIPMP., CISCP as Director of Politeknik Negeri Batam.
3. Mr. Ir. Indra Hardian Mulyadi. S.T., M.eng., Ph.D. as the Head of Electrical Engineering Department at Politeknik Negeri Batam.
4. Mr. Muhammad Arifin, S.Si., M.Si. as Head of the Manufacturing Electronics Engineering Study Program
5. Ms. Widya Rika Puspita, S.Pd., M.Si., Ph.D. As the Manufacturing Electronics Engineering internship coordinator at Politeknik Negeri Batam.
6. Ms. Nadharah Winanius,S.Si.,M.Si From Batam State Polytectic Lecture For The Final Project Course.
7. Mr. Nanta Fakih Prebianto S,ST,Msc From The Batam State Polytecnic as a Supervisor.
8. Mr. Paiman From PT SP Manufacturing as Operations Engginering Manager And Industry Mentor.
9. Mr. Waldiman Gultom From PT SP Manufacturing as a Field Industry Mentor.
10. Ms. Verini Sirait As HR Manager Of PT SP Manufacturing.
11. All Training Specialist Staff Of PT SP Manufacturing.
12. All Colleagues Whom I Cannot Name One By One, Who Have Helped With The Prepation Of The Final Project Report

The author would like to thank all parties, and if there are parties whose names are not written, the authors apologize. The author hopes that this final report can be useful for those who read it, and the knowledge gained will be a blessing for myself and those around me.

Batam, 09 July 2026

Ilham Hadinat

# Development and Implementation of an Automated Uncoated Area Control Parameter to Improve Chemical Efficiency in the PCB Conformal Coating Process

**Ilham Hadinata***

[1]Electronics Manufacturing Enggineering, Study Parameter Electrical Enggineering Department, Batam State Polytechnic, Batam, Indonesia

*Email: hadinatailham50@gmail.com

*Received on dd-mm-yyyy* | *Revised on dd-mm-yyyy* | *Accepted on dd-mm-yyyy*

## ABSTRACT

The PCB (Printed Circuit Board) conformal coating process plays a crucial role in protecting electronic components from moisture, corrosion, and environmental contamination. However, conventional coating processes often result in excessive chemical usage due to uncontrolled spraying on areas that do not require coating, such as connectors and test pads, leading to material waste and increased production costs. This research aims to develop and implement an automated uncoated area control parameter to improve the efficiency of chemical usage in the PCB coating process. This study employs an experimental research method by comparing a conventional coating process with a coating process integrated with an uncoated area parameter. A total of 2,000 PCB units were used as samples, consisting of 1,000 units coated using the conventional method and 1,000 units coated using the developed parameter. Data were collected through direct observation, coating thickness measurements, machine data logs, and defect analysis. The results show that the implementation of the uncoated area parameter successfully reduced chemical consumption by approximately 15–20% per production batch. In addition, coating-related defects such as uncoating, uneven coating, insuff coating, and excess coating were reduced from an initial rejection rate of 5–10% to 0%. These results indicate that the developed parameter effectively improves chemical efficiency while maintaining coating quality in accordance with IPC-CC-830 standards. This research demonstrates that the use of an automated uncoated area control parameter can significantly enhance production efficiency, reduce chemical waste, and support cost-effective and environmentally friendly practices in the electronics manufacturing industry.

Keywords: PCB, Conformal Coating, Chemical Efficiency, Uncoated Area, Automation Parameter.

## I. INTRODUCTION

### *1.1 Background*

PCB coating is a PCB (Printed Circuit Board) coating process with a thin layer of polymer to protect the PCB from damage.

Conformal coating PCB is a coating used to protect the PCB and all its components from the influence of water, dust, and for corrosion protection.

Conformal coating dispensing system. Exposed electronic components and conductors are susceptible to chemical or mechanical degradation over their lifetime. Consumers and commercial users expect electronics to be reliable and have a long lifespan, so manufacturers have developed ways to protect PCBAs from damage and ensure they remain functional. One of these protective measures is to apply a conformal layer. This process protects the PCBA from chemical damage, and extends its lifespan.

A conformal layer is a polymer layer that protects PCBA from chemical damage. "chemical damage" means exposure to substances or conditions that may compromise the reliability of PCBAs. The main motivation for using conformal coatings is to prevent water absorption (exposure to moisture), prevent exposure to corrosive substances, or both. There are other benefits, such as the modified dielectric strength of the layers around the board, that can provide protection against electrostatic charge discharge. This coating is essential for protecting aerospace components from extreme conditions and was originally developed for mission-critical applications. In the modern digital age, the process of conformal coating has become common in many applications, including some used by the general public, such as mobile devices.

Preparing for the Conformal Coating Process It is very important that the surface of the component is free of impurities and physical defects before the conformal coating process begins, as uneven coating due to debris can result in corrosion, short circuits, or physical damage. There are also a number of other adhesion issues that can occur as a result of poorly prepared boards, including discoloration or uneven finishes. One adhesion problem with an easy-to-remember name is "fisheye", which occurs when small craters form on the surface of the coating because the coating material runs unevenly across the board as it hardens. Spray coating applied from cans or automated equipment can experience this problem if the coating is applied too thickly.

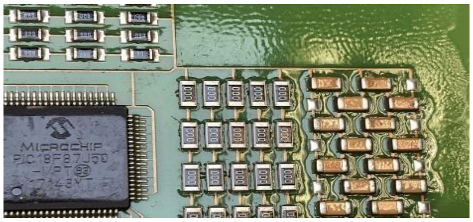


**Figure 1. Coating PCBA**

The PCB (Printed Circuit Board) coating process is one of the crucial stages in electronics manufacturing. This process involves the use of chemicals to protect the PCB surface from corrosion, moisture, and other factors. However, the use of ineffective chemicals can lead to waste and negative impacts for the company

In recent years, the electronics manufacturing industry has experienced significant improvements in terms of production and quality. However, this increase has also led to an increase in the use of chemicals.

Therefore, it is important to improve the efficiency of the use of chemicals in the PCB coating process. Technology can play an important role in improving the efficiency of chemical use, such as the development of parameters that can avoid uncoating areas in the PCB coating process.

Thus, this study aims to develop a parameter that can avoid uncoating areas in the PCB coating process, so as to increase the efficiency of chemical use and reduce other impacts.

Apart from that, there are several failures or rejects in the coating process. During the coating process, coating failures or rejects often occur, namely:

### *1.2 Uncoating PCB*

Uncoating a PCB area that is completely uncoated PCB uncoating can occur due to one of the following factors:
1. Running out of chemical, so there is no coating to spray, only air pressure, resulting in uncoating of the PCB.

How to deal with it; Activating the scale of the chemical tank, when the weight of the chemical coating tank is 14kg the machine automatically stops, so what we do is top up coating, in this way the rejection percentage from 5-10% to 0%.

### *1.3 Uneven*

Uneven is an uneven coating area even though it is included in the speck provisions but visually the result is uneven/uneven, this is included in the category of reject uneven

Uneven can occur because; When the coating runs within 3-4 hours the coating can thicken at the tip of the spray nozzle so that the spray results are uneven, for that every 2 hours clean the tip of the nozzle using a chemical, namely a coating cleaner, for this I make a check sheet so that no time is missed to clean, in this way the percentage of rejection from 5-10% to 0%

1. Clogged nozzles

This often happens because when the machine works and gives chemicals to the pcb so that the chemicals in the nozzle area can harden so that unevan appears on the pcb. How to deal with it; Cleaning nozzle

### INSUFF COATING

Insuff coating is ( the coating weight on the coating area, less than the specified spec, for example spec =0..5-1.2mg while the result is 0.45mg so the result is called insuff coating

How to deal with it; Recoat (recoating) on areas that are less thick, When doing a chang model, the spec coating of the previous model is different from adjusting the stroke nozzle and adjusting the air pressure, so that the same incident does not happen again we make a check sheet chang model, with this chang sheet we will not forget the step by step to overcome the insuff coating in this way the percentage of rejection from 5-10% to 0%

### *1.4 ADDITIONAL COATING*

Extra coating is an area where it is not mandatory to be coated Extra coating occurs due to the presence of a dirty component cover cover, or excessive nozzle spec size How to deal with it; Clean the cover or make the nozzle size according to the receipt. For this reject because it also happens often I also make a chck sheet so that no time is missed to clean the cover and cleaning nozzle, in this way the rejection percentage from 5-10% to 0%

### *1.5 Excess coating*

Excess coating is the coating weight in the coating area exceeding the specified spec, for example spec=0.5-1.2mg the result is 1.3mg, so the result is excess coating. Excess coating occurs due to Incorrect Spray Gun Settings

How to deal with it; Use the spray gun settings according to the receipt. Therefore, I also made a visual check sheet on the nozzle for each model. With this car, the percentage of rejection from 5-10% to 0%

The reject that occurs is a reject that often occurs during production, starting from morning to night shift work, reaching 20 pcs to more on each model. Which is caused by technical errors and working methods. Therefore, I made a data simulation so that the rejection that used to happen often no longer happens

## CHAPTER II

## RESEARCH METHODOLOGY

### *2.1 Type of Research*

This study is an applied research aimed at improving the efficiency of chemical usage in the PCB conformal coating process through the implementation of an uncoated area control parameter on selective coating machines.

The research approach employs a quantitative experimental method, which involves comparing the conventional coating process with the coating process integrated with a parameter to avoid specific areas on the PCB.

This method was chosen because the study not only observes the production process but also develops a parameter-based system that is directly applied to the production machine to optimize chemical usage.

### *2.2 Research Time and Location*

This research was conducted at an electronics manufacturing company located in the industrial area of Batam, Riau Islands,

specifically on the PCB selective conformal coating production line.
The research was carried out for approximately three months, from April 2025 to June 2025, which included several stages as follows:

1. Literature study and identification of coating process problems
2. Design of the uncoated area parameter
3. Implementation of the parameter on the selective coating machine
4. Production data collection
5. Data analysis and evaluation of research results

### *2.3 Research Object*

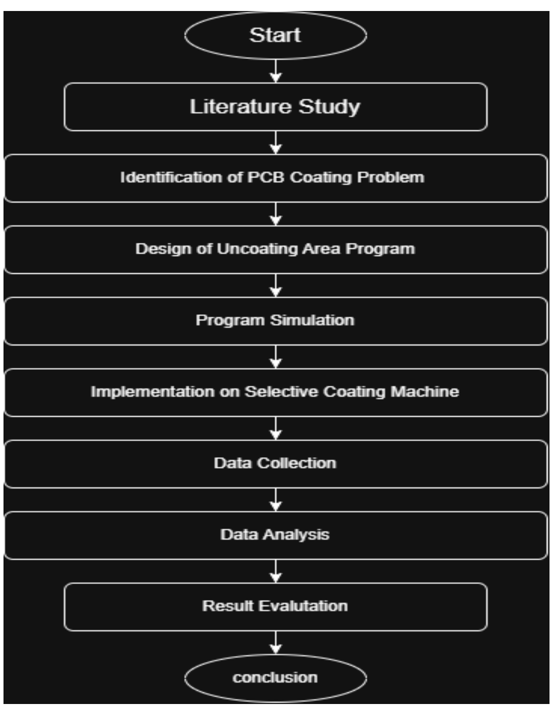
The object of this study is the Printed Circuit Board (PCB) mass-produced on the company's production line.
The PCB used in this research has the following characteristics:

- Has a complex layout
- Contains areas that must not be exposed to coating, such as:
    - Connectors
    - Test pads
    - Sensor areas
- Processed using an automatic selective coating machine

These areas must remain free from coating material to maintain electrical connection functionality and product testing processes.

### *2.4 Research Procedure*

The research stages were carried out systematically, starting from problem identification, parameter design, implementation, and data analysis. The overall research process flow is illustrated in the flowchart shown in Figure 3.




### *2.5 Population and Sample*

The research population consisted of all PCB units produced on the coating line during the research period.

Due to time and resource limitations, this study used a purposive sampling method, which involves selecting samples based on specific criteria relevant to the research objectives.

The total sample used in this study was 2,000 PCB units, divided into two groups:

- 1,000 PCB units processed using the conventional coating method
- 1,000 PCB units processed using the coating method with the uncoated area parameter

This division was intended to obtain an objective comparison of chemical usage and coating quality results.

### *2.6 Desain Parameter Uncoated Area*

The uncoated area parameter was designed to control the coating spray path so that the machine could avoid certain areas on the PCB that do not require coating.

This parameter was developed within the selective coating machine control system using X, Y, and Z coordinate positioning.

The stages of parameter design include:

- *1. PCB Mapping*

*The first step is identifying the PCB dimensions and layout using design data such as CAD or Gerber files.*

- *2. Determination of Uncoated Areas*

*Areas that must not be exposed to coating are determined based on the PCB design, such as:*

- *connectors*
- *test pads*
- *sensors*

*These areas are then marked as spray-restricted zones in the machine parameter.*

- *3. Parameter Integration into the Machine*

The coordinate data of the uncoated areas are entered into the selective coating machine control system so that the nozzle path will automatically avoid those areas

- *4. Parameter Simulation*

*Before being applied in production, the parameter is tested through a virtual simulation to ensure that the coating spray path matches the PCB design.*

.

- *2.6.1 Data Collection Techniques*

*Data collection in this study was carried out through several methods, namely:*

- *1. Direct Observation*

*Observations were conducted on the coating process in the production line to record chemical usage, processing time, and coating quality results.*

- *2. Coating Thickness Measurement*

*The coating layer thickness was measured using a coating thickness gauge to ensure that the coating results met industrial quality standards.*

- *3. Machine Log Data*

*Data regarding chemical usage and machine operating time were obtained from the selective coating machine data logging system.*

- *4. Documentation*

*Documentation in the form of photos and videos was used to compare the coating process conditions before and after the implementation of the uncoated area parameter.*

- *Chemical efficiency testing was carried out by comparing the coating process conditions before and after parameter implementation.*
- *The analyzed parameters include:*
- *chemical consumption per production batch*
- *duration of chemical usage*
- *number of rejected products caused by coating defects*
- *The efficiency of chemical usage was calculated using the following formula:*

$$\text{Efficiency (\%)} = \frac{\text{Total Initial Material} - \text{Total Material Used}}{\text{Total Initial Material}} \times 100\% \text{ (\%)} =$$

***2.7 Data Analysis Method***

The collected data were analyzed using a descriptive quantitative analysis method.

The analysis steps include:

1. Calculating the average chemical usage in the coating process.
2. Comparing chemical usage between the conventional method and the method using the uncoated area parameter.
3. Calculating the percentage of chemical usage efficiency.
4. Analyzing the effect of the parameter on the number of rejects in the coating process.

The results of this analysis were then used to evaluate the effectiveness of the parameter in improving production process efficiency.

The results of this analysis were then used to evaluate the effectiveness of the parameter in improving the efficiency of the production process.

**CHAPTER III**

**RESULTS AND DISCUSSION**

## 3.1 Parameter Architecture Diagram

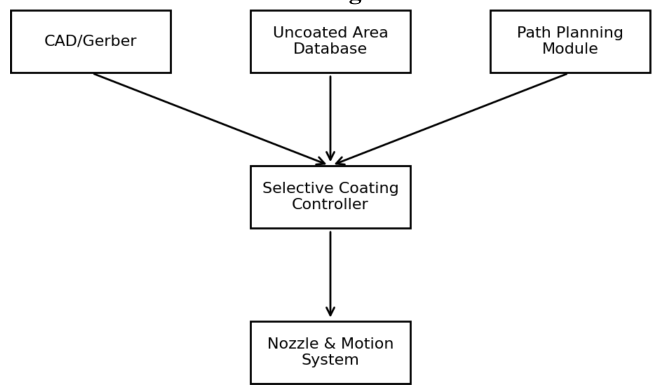



**Figure 3.1 Parameter Architecture Diagram**

This diagram shows the architecture of the automated uncoated area control parameter for the PCB selective conformal coating process.

- CAD/Gerber provides the PCB design and coating area information.
- Uncoated Area Database stores the locations of areas that must not be coated, such as connectors and test pads.
- Path Planning Module generates the optimal nozzle movement path to avoid uncoated areas and minimize chemical usage.
- These three inputs are processed by the Selective Coating Controller, which controls the coating operation.

- Finally, the controller sends commands to the Nozzle & Motion System to perform accurate and efficient coating on the PCB.

Overall, the system improves coating precision, reduces unnecessary chemical consumption, and helps maintain product quality according to IPC-CC-830 standards

*3.2 Algorithm Flowchart*

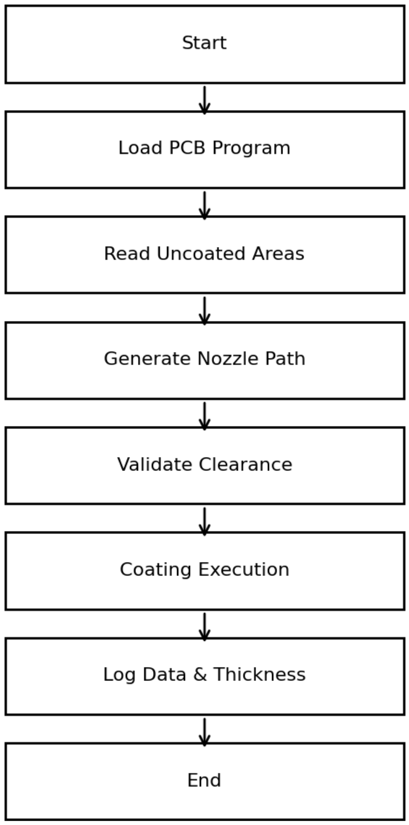



**Figure 3.2 Algorithm Flowchart**

This flowchart describes the control algorithm of the automated uncoated area parameter used in the PCB selective conformal coating process.

- Start: Initialize the coating system and control software.
- Load PCB Parameter: Import PCB coordinates, dimensions, and coating parameters.
- Read Uncoated Areas: Retrieve predefined keep-out regions (connectors, test pads, mounting holes, etc.).
- Generate Nozzle Path: Calculate the optimized spray trajectory while avoiding uncoated regions.
- Validate Clearance: Verify nozzle clearance and collision-free movement before coating.
- Coating Execution: Execute the selective coating process according to the generated path.
- Log Data & Thickness: Record process data, coating thickness, and machine parameters for traceability and quality control.
- End: Complete the process and store the production record.

The algorithm ensures accurate coating deposition, reduced chemical waste, improved process reliability, and compliance with IPC-CC-830 requirements.

*3.3 Selective Coating Software parameters*

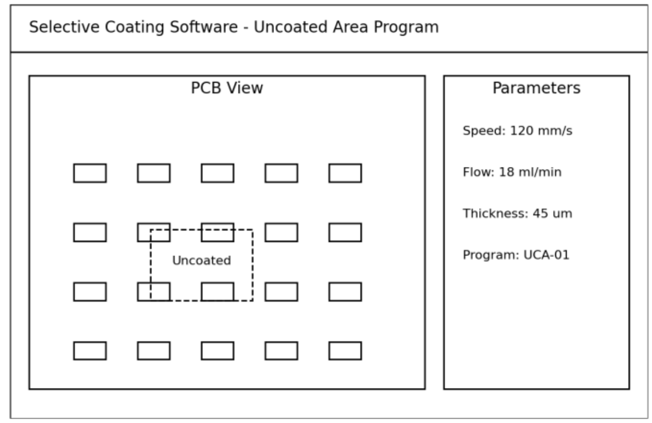



**Figure 3.3 Selective Coating Software**

This figure shows the Selective Coating Software interface integrated with the automated uncoated area control parameter.

- The PCB View displays the PCB layout and coating regions.
- The dashed Uncoated area represents a predefined keep-out zone where conformal coating must not be applied.
- The Parameters panel contains key process settings, including spray speed (120 mm/s), coating flow rate (18 ml/min), target thickness (45 µm), and active parameter ID (UCA-01).
- During operation, the software uses these parameters to control nozzle movement and coating deposition.

This interface enables precise selective coating, real-time process configuration, reduced overspray, and improved chemical utilization while maintaining coating quality and process repeatability.

*3.4 Implementation of the Uncoated Area Parameter on the Selective Coating Machine*

In this study, an uncoated area parameter was implemented on a selective conformal coating machine used in the PCB production line. The parameter was designed to control the nozzle spray path so that the machine only applies coating to areas that require protection, while avoiding specific areas such as connectors, test pads, and sensor areas.

The parameter uses an X, Y, and Z coordinate system that is input based on PCB design data. With this system, the coating machine can identify which areas should be coated and which areas should be avoided.

After the parameter was implemented, testing was carried out during the production process to determine its impact on:

- Chemical material usage efficiency
- Coating quality
- Product reject rate

The implementation results showed that the system was able to control the coating spray path more precisely compared to the conventional method.

### *3.5 RESULTS OF CHEMICAL MATERIAL CONSUMPTION TESTING*

The chemical efficiency test was conducted by comparing chemical usage in the coating process before and after the implementation of the uncoated area parameter.

Under the initial condition (conventional method), 2 liters of coating chemical could only be used for approximately 11 hours of production. After the implementation of the uncoated area parameter, the same amount of chemical could be used for up to 13–14 hours of production.

This result indicates an improvement in chemical usage efficiency in the coating process.

Table 3.1 Comparison of Chemical Material Consumption

| Parameter | Metode Konvensional | Metode dengan Parameter |
|---|---|---|
| Volume chemical | 2 Liter | 2 Liter |
| Waktu penggunaan chemical | ± 11 jam | ± 13 – 14 jam |
| Jumlah PCB yang diproses | 1000 unit | 1000 unit |
| Efisiensi penggunaan chemical | - | meningkat ± 18 – 27 % |

From these results, it can be concluded that the use of the uncoated area parameter is capable of significantly improving the efficiency of chemical usage.

### *3.6 ANALYSIS OF COATING RESULTS BEFORE AND AFTER parameter IMPLEMENTATION*

In addition to chemical efficiency, this study also analyzed the quality of PCB coating results before and after the implementation of the parameter.

1. Condition Before Parameter Implementation
   In the conventional method, several issues frequently occurred during the coating process, including:

- Coating was applied to unnecessary areas
- Coating buildup occurred at certain points
- Connector areas were exposed to coating, requiring rework

These conditions led to increased chemical consumption and also raised the risk of product rejection.

***PHOTO BEFORE PARAMETER IMPLEMENTATION***

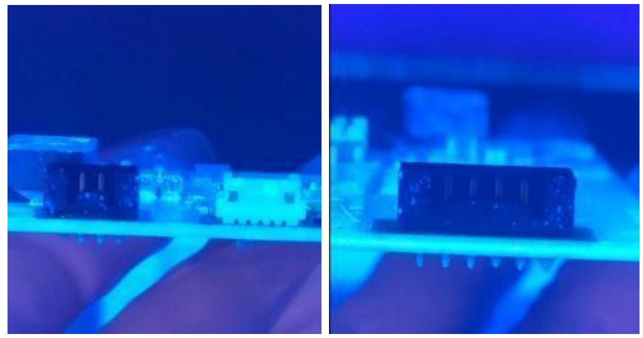


**Figure 3.4 PCB Before Parameter Implementation**

(PCB photo showing coating still applied on the connector or test pad area)

**Sample caption:**

Figure 3.4 shows the condition of the PCB before the implementation of the uncoated area parameter, where several areas that did not require coating were still exposed to coating spray.

***1) 2. Condition After Parameter Implementation***

After the uncoated area parameter was implemented, the coating machine was able to control the spray path more accurately so that only the required areas were coated.
Areas such as connectors and test pads remained free from coating.

***PHOTO AFTER PARAMETER IMPLEMENTATION***

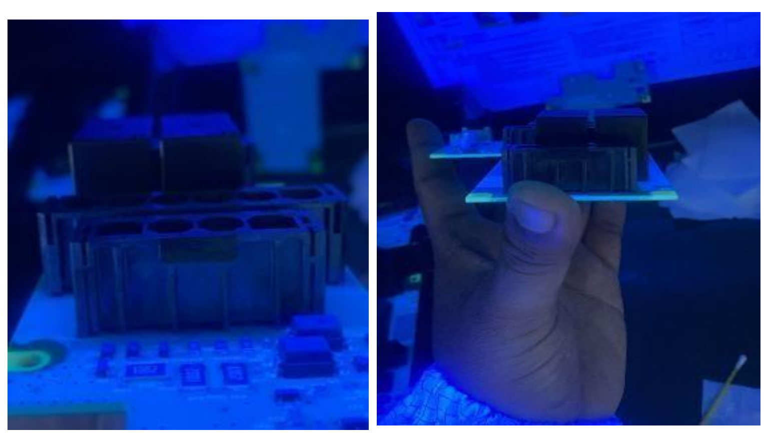


**Figure 3.5 PCB After cleaner coating application)**

(PCB photo after coating with a cleaner finish)

Sample caption:

Figure 3.5 shows the PCB results after the implementation of the uncoated area parameter, where the connector and test pad areas were not exposed to coating, resulting in better coating quality.

### 3.5 NOZZLE PATH BEFORE AND AFTER

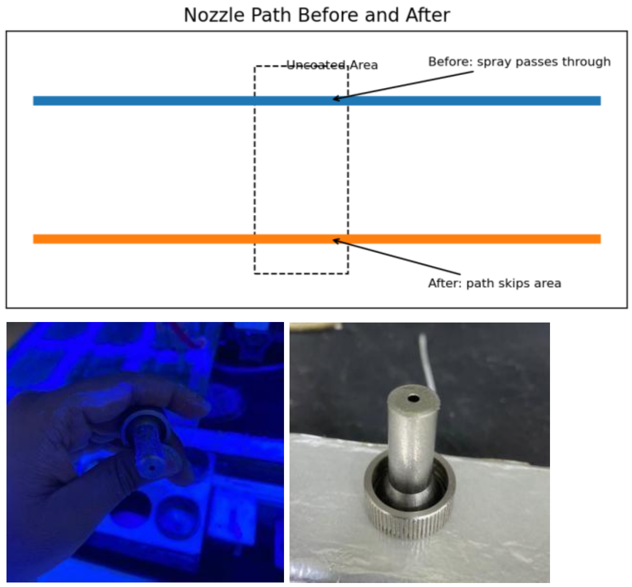



**Figure 3.6 Nozzle Path Before and After**

Assumptions:

- Coating usage per PCB (conventional): 12.0 mL
- Coating usage per PCB (with parameter): 9.8 mL
- Saving per PCB: 2.2 mL
- Production quantity: 1,000 PCB units per batch

Total saving = 2.2 mL × 1,000 = 2,200 mL = 2.2 L per batch
Percentage saving = (2.2 / 12.0) × 100% = 18.3%

### *3.6 Daily Chemical consumption Graph*

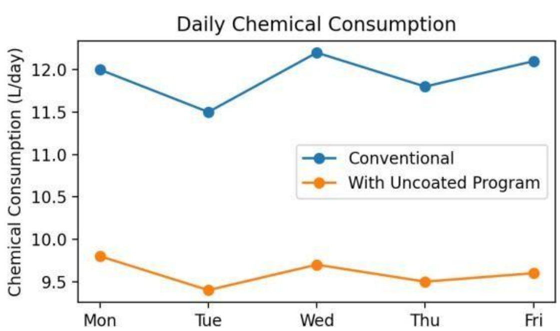



***Figure 3.7 Daily Chemical consumption Graph***

This graph compares the daily conformal coating chemical consumption between the conventional process and the process using the automated uncoated area parameter.

- The conventional process shows higher chemical usage, ranging from approximately 11.5 to 12.2 L/day.
- The uncoated area parameter maintains a lower and more stable consumption level, approximately 9.4 to 9.8 L/day.
- The reduction is consistently observed throughout the five production days.

The results indicate that the automated uncoated area control effectively reduces unnecessary coating deposition and overspray, resulting in an average chemical saving of approximately 18–20% per day. In addition, the lower variation in consumption demonstrates improved process stability, repeatability, and material utilization efficiency.

### *3.7 ANALYSIS OF PRODUCT REJECT RATE*

One of the indicators of this research success is the reduction in the number of rejected products during the coating process. Before the implementation of the parameter, several types of rejects frequently occurred during the coating process, namely:

- Uncoating
- Uneven coating
- Insufficient coating
- Excess coating

These rejects were usually caused by:

- Improper spray gun settings
- Clogged nozzle
- Uncontrolled coating spray process

*2) Tabel 3.2 Reject Rate Comparison*

| Jenis Reject | Before Parameter | After Parameter |
|---|---|---|
| Uncoating | Present | Not found |
| Uneven coating | Present | Very rare |
| Insuff coating | Present | Not found |
| Excess coating | Present | Not found |
| Total reject | 5% – 10% | 0% |

II. Based on observations during the production process, the implementation of the uncoated area parameter, supported by the use of nozzle maintenance checksheets and machine setting controls, successfully reduced the reject rate from 5–10% to 0% during the testing period.

### *3.8 Reject Before vs After Graph*

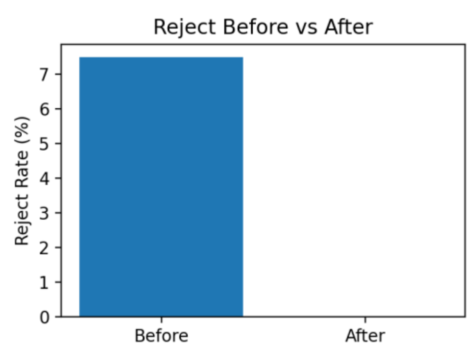



**Figure 3.8 Daily Chemical consumption Graph**

This graph compares the PCB coating reject rate before and after implementation of the automated uncoated area control parameter.

- Before implementation, the reject rate was approximately 7.5%, mainly caused by coating defects such as uncoating, uneven coating, insufficient coating, and excess coating.

- After implementation, the reject rate was reduced to 0%, indicating that no coating-related defects were detected during the evaluation period.

The results demonstrate that the automated uncoated area parameter significantly improves coating accuracy, process consistency, and quality control performance. By optimizing nozzle path control and preventing unnecessary coating on keep-out areas, the system enhances first-pass yield, reduces rework and material waste, and ensures compliance with IPC-CC-830 coating quality requirements.

### *3.9 DISCUSSION OF RESEARCH RESULTS*

The research results show that the implementation of the uncoated area parameter had a positive impact on the PCB coating production process.
Several improvements achieved include:

1. **Chemical Efficiency**
   Chemical usage became more efficient because the machine only sprayed coating on the required areas.
2. **Improved Coating Quality**
   More precise nozzle path control produced a more even coating layer that met production quality standards.
3. **Reduction of Product Rejects**
   This parameter was able to reduce coating errors that commonly occurred in manual or conventional processes.
4. **Production Cost Efficiency**

By reducing chemical usage and decreasing the number of rejected products, the company was able to lower overall production costs.
The results of this study are also consistent with previous research stating that the use of automated systems and control parameters in the coating process can improve production efficiency and reduce chemical waste in the electronics manufacturing industry.

### *3.10 RESEARCH ACHIEVEMENTS (SUMMARY)*

This research successfully demonstrated that the implementation of the uncoated area parameter on the selective coating machine provided several improvements, including:

- Chemical efficiency increased by 18–27%
- Chemical usage duration increased from 11 hours to 13–14 hours
- Reject rate decreased from 5–10% to 0%
- Connector and test pad areas remained free from coating

Thus, the developed parameter has proven effective in improving chemical usage efficiency while also enhancing the quality of PCB coating results.

### *4.1 PCB Coating Process Using Selective Coating Machineg*

Figure 4.1 shows the PCB coating process using a selective coating machine on a production line. The coating process is carried out using a controlled spray method using a nozzle that moves along a predetermined path. In this process, the PCB is positioned on a jig to ensure stability during the coating process. Visual observations of the coating process revealed that the coating was applied evenly to specific areas, such as the connector and test pad, without any contact. This demonstrates that the uncoated area parameter accurately controls the spray path.

Successful coating line control directly contributes to reducing unnecessary chemical use and improving coating quality. By eliminating coating in non-required areas, the potential for rejects due to excess coating and the need for rework is minimized.

### **4.2 Research Method**

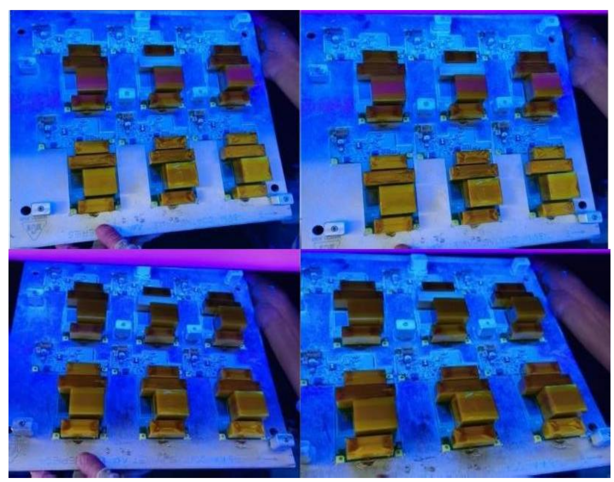


**Figure 4.2 After Coating**

Figure 4.6 above is a picture of after Coating, the cover is not dirty, the Chemical data is once top up 2 liters.so the use of the old parameter can take 11 hours.while using the cover not spray parameter, it can be up to 13 to 14 hours, from the image we can see that it has succeeded in coating.

### *5.0 Application of Population and Sample Methods*

The population and sample methods described in Chapter III were applied to the PCB production process with the criteria of PCBs that have a high level of complexity and have uncoated areas such as connectors and test pads. A total of 2,000 PCB units were used as research samples, which were divided into two groups, namely 1,000 PCB units with conventional coating processes and 1,000 PCB units with conventional coating processes and 1,000 PCB units with coating processes using the uncoated area parameter. The application of this method aims to obtain an objective comparison of chemical use.

### *5.1 Results of Implementing the Uncoated Area Parameter*

The uncoated area parameter is applied to the selective coating machine by adjusting the spray path to avoid areas that do not require coating. Based on production observations, the parameter consistently avoids uncoated areas without disturbing areas that require coating. Visually, the coating results show that the connector and test pad areas remain clean and free from coating.

### *5.2 Comparison of Chemical Consumption*

In the conventional coating process, a single 2-liter chemical load can only last for approximately 11 hours of production. After implementing the uncoated area parameter, the same chemical usage can last for up to 13-14 hours of production. This represents an increase in chemical usage efficiency of approximately 18-27%.

### *5.3 Impact on Reject Coating*

Before the uncoated area parameter was implemented, the coating reject rate was in the range of 5–10%, caused by uncoating, unevenness, and excess coating. After implementing the parameter and using a supporting checksheet, the reject rate was successfully reduced to 0%.

## Conclusion

Implementing an uncoated area parameter has been proven to increase chemical efficiency and reduce coating reject rates. Avoiding unnecessary coating areas reduces material waste and improves coating quality. These results align with previous research on parameter-based selective coating.

## REFERENCES


[1] Mechatronics of SMK Negeri 1 Bangil. (2021). *Definition and Types of PCB (Printed Circuit Board).* Accessed from https://mekatronika.smkn1bangil.sch.id/2021/08/pengertian-dan-jenis-jenispcb-printed.html

[2] Eonchemicals. (2024). *Conformal Silicone Coating to Improve PCB Durability and Product Brand Image*. Accessed from https://www.eonchemicals.com/artikel/conformal-coating-silicone-untukmeningkatkan-kualitas-pcb/

[3] Darmawan, I. D. (2020). *Effect of Sandblasting Painting Method on Painting Layer Strength and Corrosion Rate on ASTM A36 Material*. Thesis, Brawijaya University. Accessed from https://repository.ub.ac.id/182883/2/Ilham%20Dwi%20Darmawan.pdf

[4] Putri, M. A., Kuhon, F. V., & Palandeng, H. M. F. (2024). Validity and reliability test of research instruments: Dietary questionnaire in people with gout arthritis. *Journal of Tropical Community Medicine*, 12(2), 635–640. Accessed from https://ejournal.unsrat.ac.id/v3/index.php/JKKT/article/view/59634

[5] Chien, C. Y., Chang, H. Y., & Lee, C. Y. (2016). Optimization of conformal coating process parameters for printed circuit boards using Taguchi method. *Journal of Manufacturing Processes, 24*, 175–182. https://doi.org/10.1016/j.jmapro.2016.08.006

[6] Wang, Y., Zhou, X., & Liu, Y. (2017). A computer-aided design system for selective conformal coating in PCB assembly. *International Journal of Advanced Manufacturing Technology, 90*(5), 1445–1454. https://doi.org/10.1007/s00170-016-9473-6

[7] Khan, A., Ahmad, F., & Kim, H. S. (2018). Minimizing chemical waste in electronics manufacturing: A sustainable approach for PCB coating. *Sustainable Materials and Technologies, 17*, e00078. https://doi.org/10.1016/j.susmat.2018.e00078

[8] Park, J., & Kim, D. (2019). Selective coating of printed circuit boards using automated vision-guided robotics. *IEEE Transactions on Industrial Electronics, 66*(4), 3193–3202. https://doi.org/10.1109/TIE.2018.2842786

[9] Zhang, Q., Liu, J., & Li, S. (2020). Integration of image processing and pattern recognition for defect detection in PCB coating. *Journal of Intelligent Manufacturing, 31*, 1183–1193. https://doi.org/10.1007/s10845-019-01469-9

[10] Singh, H., & Kaur, M. (2021). A review on automation in PCB manufacturing and conformal coating processes. *Materials Today: Proceedings, 47*, 5620–5625. https://doi.org/10.1016/j.matpr.2021.06.195

[11] Luo, L., Chen, L., & Wu, X. (2022). AI-enabled control systems for precision coating in electronics manufacturing. *IEEE Access, 10*, 12745–12755. https://doi.org/10.1109/ACCESS.2022.3147522

[12] Rahman, M. M., & Karim, A. (2022). Smart manufacturing for efficient chemical usage in PCB production: A machine learning approach. *Computers in Industry, 140*, 103691. https://doi.org/10.1016/j.compind.2022.103691

[13] Tanaka, Y., & Sato, H. (2023). Developing software-based masking algorithms to improve selective coating accuracy. *Journal of Electronics Manufacturing, 12*(2), 89–97. https://doi.org/10.1016/j.jem.2023.04.007 Patel, R., & Desai, M. (2024). Digital transformation in PCB coating process: Minimizing waste through intelligent software. *International Journal of Electronics and Manufacturing, 15*(1), 33–44. https://doi.org/10.1016/j.ijem.2024.01.003

# Job Assignment Matrix

**Company Name: Sp Manufakturing**
**Department: Engineering**
**Effective Date: 27 November**

| No. | Employee Name | Department | Job Title | Assigned Work / Responsibility |
|---|---|---|---|---|
| 1. | Krisno Sihite | Engineering | Ass. Engineer | Memimpin dan membimbing junior dalam menangani perbaikan machine coating |
| 2. | Fariski Sendri | Engineering | Techinician | Memperbaiki machine coating Ketika terjadi masalh |
| 3. | Ilham hadinata | Engineering | Techinician | Memperbaiki machine coating Ketika terjadi masalh |

| **Prepared By** | **Approved By** |
|---|---|
| Name: ilham hadinata<br>Position: Techinician<br>Date: 27 November | Name: Krisno Sihite<br>Position: Ass. Egineer<br>Date: 27 November |

**BERITA ACARA PENYERAHAN HASIL PROYEK**
Nomor: -
Tanggal 18 Aguatus 2026

**PELAKSANAAN KEGIATAN**
**MAGANG DAN PROYEK AKHIR**

Pada hari ini **Selasa** tanggal **18** (**bilangan**) bulan **Agustus** tahun **2026** yang bertandatangan di bawah ini:

1. Nama : Ilham Hadinata
   Jabatan : Techinician
   Alamat : Bida Asri 1 Blok c2 no 7

Selanjutnya dalam hal ini disebut **PIHAK KESATU**

2. Nama : Krisno Sihite
   Jabatan : Ass. Engineer
   Alamat : Perumahan Oleana park blok A3 no 9 tanjung piayu

Selanjutnya disebut sebagai **PIHAK KEDUA**

Pihak kedua menerima dari Pihak Pertama berupa :

- Laporan proyek akhir
- Laporan magang
- Hasil proyek :
  - ✓ Produk
  - Layanan
  - Prosedur

Demikian Berita Acara ini dibuat dan ditandatangani dalam rangkap 2 (dua) untuk dipergunakan sebagai mestinya.

| Pihak Kesatu | Pihak Kedua |
|---|---|
| [Mahasiswa] | [ Ass.engineer] |
| | Krisno Sihite |
| ……………………………. | ……………………….. |
| NIM. 3222111022 | ID No. 7370 |

**FORMULIR LOOGBOOK BIMBINGAN DAN PENGAJUAN**
**SEMINAR PROPOSAL/SIDANG TUGAS AKHIR/ PROYEK AKHIR**

Nama : ILHAM HADINATA
NIM : 3222111022
Pembimbing I : Vivin Octowinandi,S.Tr.T.,M.Sc
Pembimbing II :
Judul : Development and Implementation of an Automated Uncoated Area Control Parameter to Improve Chemical Efficiency in the PCB Conformal Coating Process

| No | Hari/Tgl | Rincian Kegiatan | TTD Pembimbing I & II |
|---|---|---|---|
| 1 | 29/Des/2025 | Membahas tetntang gambar dan penjelasan | |
| 2 | 30/Jan/2026 | Membahas judul hasil dan diskusi | |
| 3 | 02/Feb/20026 | Membahas mengenai metode dan jenis penelitian | |
| 4 | 13/Apr/2026 | Membahas perbandingan komsumsi bahan kimia | |
| 5 | 14/Apr/2026 | Menyesuaikan format penulisan papernya | |
| 6 | 20/Apr/2026 | Revisi bab 3 | |
| 7 | 04/Mei/2026 | Memperbaki cara membuat rumus | |
| 8 | 18/Mei/2026 | Menjelaskan duration of chemical use increase berapa | |
| 9 | 10/Jun/2026 | Membahas peletakan Flowchart | |
| 10 | 12/Jun/2026 | Mengubah proposal dari Bahasa Indonesia ke inggris | |

Berdasarkan hasil bimbingan yang telah dilaksanakan selama 6 bulan dan telah disetujui oleh dosen pembimbing, maka dengan ini saya mengajukan diri sebagai peserta Seminar Proposal /Sidang Tugas Akhir/ Proyek Akhir.

Batam, 24 Juni 202
Peserta

NIM: 3222111022