

# Optimization of IC 32 QFP Pick Up Parameters

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## Abstract

In the pick and place machine with the SM421 model located at TFME (Teaching Factory Manufactur Electronic), until now there has not been an optimal size and parameters for 32 QFP IC components. So that when using the IC 32 QFP component, the machine user must first update or change the component size and determine the parameters. This will take a long time. In its own concept, the purpose of using a pick and place machine in the SMT process is to pick and place small components onto the PCB pad quickly and accurately (without offset). The purpose of this optimization is to shorten the process time when using 32 QFP IC components on a pick and place machine. In optimizing this machine, the DOE method is carried out by experimenting with several parameters and then comparing the results of each combination. The results of this study are based on a small offset and the offset value does not exceed the class 3 standard. So based on the experiments that have been carried out, the optimal parameters are in combination 2 with a pick up delay time of 50s and using soft touch (mount).

**Keywords : QFP, Parameter, Pick and place, DOE**

## 1. Introduction

Integrated Circuit or abbreviated as IC is an active electronic component consisting of a combination of hundreds, thousands, even millions of transistors, diodes, resistors and capacitors integrated into an electronic circuit in a small package. The main material that makes up an Integrated Circuit (IC) is semiconductor material [1]. There are various types of IC packages that are commonly used, namely Quat Flat Packages (QFP), Ball Grid Arrays (BGA), Single In-line Packages (SIP), and so on. IC 32QFP is one type of package that has the number of legs 8x8 and sized 7x7 mm. This component is included in the SMD component type.

Based on the TFME case, the pick and place machine does not yet have the right standard parameters for IC 32 QFP components. So when you want to use this component, you have to set it first, from the package size to other parameters. TFME itself is divided into several process sections, namely IC Packaging process, PCB manufacturing process, and SMT process. This project is carried out in the SMT process, precisely on the Pick and place machine.

Surface mount technology (SMT) is well-known as an essential method for electronic component assembly. The main operations in a surface mount assembly (SMA) line are stencil printing process (SPP), pick and place (P&P), and solder reflow [2]. In the printing process, the printer machine puts solder paste onto the pads of the PCB. Next, a mounter picks and places components on pads. Finally, a reflow oven melts solder paste, making attachments

between components and pads by forming solder joints [3].

Pick and place is the process of installing electronic components on the surface of a printed circuit board without holes for cables. The main reasons to consider implementation of SMT include the following: Reduction in circuit board size, Reduction in circuit board weight, Reduction in number of layers in the circuit board and Reduction in trace lengths on the circuit board. Thermal management issues remain major concerns in the successful design of an SMT board and product [4]. Surface mount devices (SMDs) that use in SMT process such as chip scale packages (CSPs), direct chip attach (DCA), and ball grid arrays (BGAs) are currently satisfying the need for higher circuitry density. The emergence of SMT has brought with it the manufacturing processes needed to assemble surface mounted PCBs [5].

Andri Rizki Pratama (2013: 6) defines optimization as an individual effort to increase activities to be able to minimize losses or maximize profits in order to achieve goals properly within a certain deadline [6]. According to S. Rao (2009) optimization is a process to achieve a state that gives the maximum or minimum value of a function. Based on some of the definitions above, it can be concluded that optimization is an attempt to achieve an optimum value by maximizing a function or minimizing the loss of that function [7].

Implementation of picking and placing components using a pick and place machine so that the components are directly on the pad and do not produce offsets, requires the right parameters. To find these parameters, the design of experiment (DoE) method is used for several variables to

be tested.

Design of Experiment (DOE) is a statistical method used in experimental design in laboratory, research, and development of new product or formula. DOE variables or factors to improve process yield, reduce variation, and decrease overall cost. DOE as a scientific experimental tool has increased significantly in the past 20 years in manufacturing and non-manufacturing industries worldwide. DOE successfully determines the most important factor or variable to control to achieve optimal process performance [8]. Optimisation of the feeder setup and component pick-and-place sequence, are important factors, which influence the efficiency of SMD placement machines [9]. This research will be carried out at TFME, to find the right parameters so that components do not offset and as a reference based on IPC A-610 [10].

## 2. Research Method

This research was carried out using experimental methods on several variables. There are several stages carried out, such as setting up the pick and place machine, carrying out inspections, and analyzing the results obtained as shown in Figure 1. The process of setting up the pick and place machine starts from inputting the size of the PCB sample, array, fiducial mark. Component input, feeder tray settings, and component placement settings on the sample PCB pad as shown in Figure 2.

This research was conducted using the experimental method. In the existing pick and place machine (SM421) at TFME, there is already a built-in parameter standard of the SM421 pick and place machine for QFP components shown in Figure 15. The parameter standard is obtained based on the IPC 9850 reference. The SM421 machine parameters are shown in Figure 16. There are several important parameters contained in this machine, including delay pick up time (ms), delay place time (ms), delay dump time (ms), speed (1 (fastest) - 5 (slowest)), soft touch and commodity size. The testing technique in this case is to give different treatments to each parameter using the DoE method to see which results are more effective. The factors and levels used in this study were determined based on the data shown in Table 1. The speed to be used is 3, nozzle CN140, place time 100 (default), dump time 300 (default). For details of the tested parameter levels are shown in Table 2 and for the DoE parameters to be tested are shown in Table 3.

To obtain optimal parameters without offset based on IPC A-610, there are several influencing variables listed in table 1.

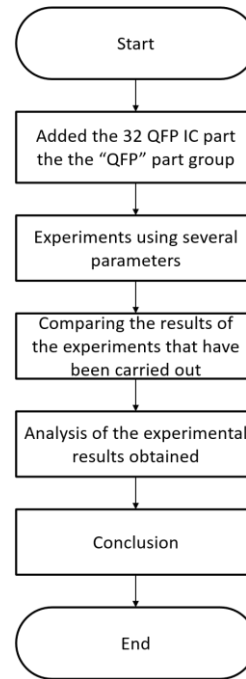


Figure 1. Flowchart Procedure Project

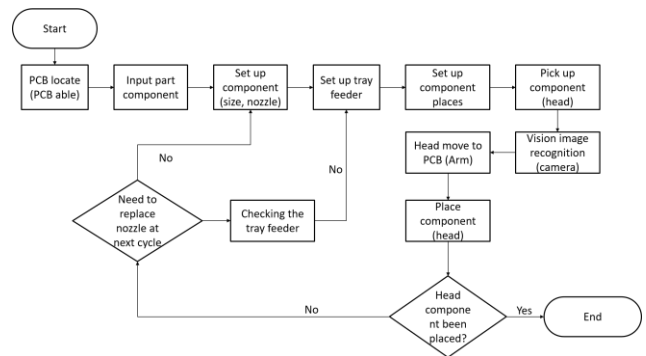


Figure 2. Block diagram of movement processes of placement machine

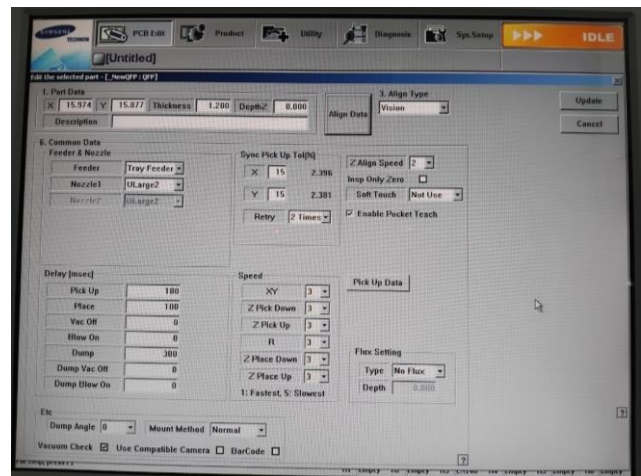


Figure 3. Standard parameters for QFP in pick and place machine

|   |
|---|
| Samsung SM421 parameters                                |
| Placement speed: 21,000 CPH / Chip (IPC9850 benchmark)  |
| 5,500 CPH / QFP (IPC9850 benchmark)                     |
| -Mounting degree: ± 50µm @ 3σ / Chip, ± 30µm @ 3σ / QFP |
| -Component range: Max, 0402 (01005) Chip ~ □ 55mm       |
| 0603 (0201) Chip ~ □ 55mm (standard)                    |
| -PCB:   |
| 460 (L) x 400 (W) mm                                    |
| 510 (L) x 460 (W) mm (option)                           |
| 610 (L) x 510 (W) mm (option)                           |
| #NAME?  |
| -Feeder: Max. 120 (8mm Feeder)                          |
| -Feeder: Max. 60 (8mm feeder) SM421S                    |
| -Appearance size: 1650 (L) x 1690 (D) x 1485 (H)        |

Figure 4. SM421 parameters

Table 1. Parameter and level for DoE

| Parameters/<br>Variables | Level         |
|--------------------------|---------------|
| Pick Up Time             | 50 (Low)      |
|                          | 150 (High)    |
| Soft Touch               | Not Use (Low) |
|                          | Mount (High)  |

Based on the table above, the number of experiments to be carried out is as follows :

$$X = \text{Number of Levels}$$

$$Y = \text{Number of Variables}$$

$$\text{Number of experiments} = X^Y$$

$$\text{Experiment} = 2^2 = 4$$

Table 2. Design of experiment testing data

| Combination | Parameters   |            | Offset Result |
|-------------|--------------|------------|---------------|
|             | Pick Up Time | Soft Touch |               |
| 1           | 50s          | Not Use    |               |
| 2           | 50s          | Mount      |               |
| 3           | 150s         | Not Use    |               |
| 4           | 150s         | Mount      |               |

### 3. Result and Discussion

This research was conducted using an Arduino UNO PCB as a medium, which was given a double tip on the IC pad so that when carrying out experiments, the components could

stick together like using solder paste. So inspections can be carried out using 3D Profiler.

The first process in running this experiment is setting the parameters of the pick and place machine with variables and parameter levels that have been determined according to table 1. Each experiment was repeated 3 times. After the component placement process (pick and place), an inspection of the results of the placement is carried out. The focus for inspection is to determine whether the quality of the parameters being tested is good or not, seen from the offset of the pad with the component feet. Measurements were carried out using a 3D Profiler on all 32 component legs. The measurement position of the object is shown in Figure 5.

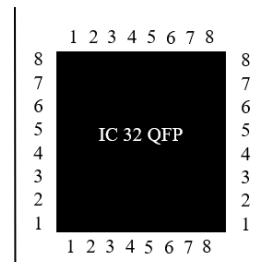


Figure 5. Offset Measurement Position

### Data Before Optimization

Table 3. Offset results with machine settings testing 1 (100s NU)

| Position Length IC | The Number of Length | Measurement per Sample Checked |      |      |      |      |      |
|--------------------|----------------------|--------------------------------|------|------|------|------|------|
|                    |                      | 1                              | 2    | 3    | 4    | 5    | 6    |
| Right              | 1                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 2                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 3                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 4                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 5                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 6                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 7                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 8                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Left               | 1                    | 0,00                           | 0,05 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 2                    | 0,00                           | 0,05 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 3                    | 0,00                           | 0,05 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 4                    | 0,00                           | 0,05 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 5                    | 0,00                           | 0,05 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 6                    | 0,00                           | 0,05 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 7                    | 0,00                           | 0,05 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 8                    | 0,00                           | 0,05 | 0,00 | 0,00 | 0,00 | 0,00 |
| Top                | 1                    | 0,00                           | 0,05 | 0,04 | 0,04 | 0,00 | 0,00 |
|                    | 2                    | 0,00                           | 0,05 | 0,04 | 0,04 | 0,00 | 0,00 |
|                    | 3                    | 0,00                           | 0,05 | 0,04 | 0,03 | 0,00 | 0,00 |
|                    | 4                    | 0,00                           | 0,05 | 0,04 | 0,02 | 0,00 | 0,00 |
|                    | 5                    | 0,00                           | 0,05 | 0,04 | 0,04 | 0,00 | 0,00 |
|                    | 6                    | 0,00                           | 0,05 | 0,04 | 0,04 | 0,00 | 0,00 |
|                    | 7                    | 0,00                           | 0,05 | 0,04 | 0,04 | 0,00 | 0,00 |
|                    | 8                    | 0,00                           | 0,05 | 0,04 | 0,04 | 0,00 | 0,00 |
| Bottom             | 1                    | 0,00                           | 0,00 | 0,00 | 0,05 | 0,03 | 0,00 |
|                    | 2                    | 0,00                           | 0,00 | 0,00 | 0,04 | 0,00 | 0,00 |
|                    | 3                    | 0,00                           | 0,00 | 0,00 | 0,04 | 0,03 | 0,00 |
|                    | 4                    | 0,00                           | 0,00 | 0,00 | 0,04 | 0,03 | 0,00 |
|                    | 5                    | 0,00                           | 0,00 | 0,00 | 0,04 | 0,03 | 0,00 |
|                    | 6                    | 0,00                           | 0,00 | 0,00 | 0,05 | 0,03 | 0,00 |
|                    | 7                    | 0,00                           | 0,00 | 0,00 | 0,05 | 0,03 | 0,00 |
|                    | 8                    | 0,00                           | 0,00 | 0,00 | 0,05 | 0,03 | 0,00 |

Table 4. Offset results with machine settings testing 2 (100s NU)

| Position Length IC | The Number of Length | Measurement per Sample Checked |      |      |      |      |      |
|--------------------|----------------------|--------------------------------|------|------|------|------|------|
|                    |                      | 1                              | 2    | 3    | 4    | 5    | 6    |
| Right              | 1                    | 0,00                           | 0,10 | 0,08 | 0,00 | 0,00 | 0,00 |
|                    | 2                    | 0,00                           | 0,08 | 0,07 | 0,00 | 0,04 | 0,00 |
|                    | 3                    | 0,00                           | 0,09 | 0,08 | 0,00 | 0,00 | 0,00 |
|                    | 4                    | 0,00                           | 0,09 | 0,07 | 0,00 | 0,00 | 0,00 |
|                    | 5                    | 0,00                           | 0,09 | 0,08 | 0,00 | 0,00 | 0,00 |
|                    | 6                    | 0,00                           | 0,08 | 0,07 | 0,00 | 0,02 | 0,00 |
|                    | 7                    | 0,00                           | 0,09 | 0,07 | 0,00 | 0,00 | 0,00 |
|                    | 8                    | 0,00                           | 0,08 | 0,07 | 0,00 | 0,00 | 0,00 |
| Left               | 1                    | 0,00                           | 0,07 | 0,07 | 0,00 | 0,00 | 0,00 |
|                    | 2                    | 0,00                           | 0,09 | 0,07 | 0,00 | 0,00 | 0,04 |
|                    | 3                    | 0,00                           | 0,06 | 0,07 | 0,00 | 0,00 | 0,00 |
|                    | 4                    | 0,00                           | 0,04 | 0,05 | 0,00 | 0,00 | 0,00 |
|                    | 5                    | 0,00                           | 0,05 | 0,08 | 0,00 | 0,00 | 0,00 |
|                    | 6                    | 0,00                           | 0,05 | 0,05 | 0,00 | 0,00 | 0,00 |
|                    | 7                    | 0,00                           | 0,05 | 0,07 | 0,00 | 0,00 | 0,00 |
|                    | 8                    | 0,00                           | 0,05 | 0,05 | 0,00 | 0,00 | 0,00 |
| Top                | 1                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 2                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 3                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 4                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 5                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 6                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 7                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 8                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Bottom             | 1                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 2                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 3                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 4                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 5                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 6                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 7                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 8                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |

Table 6. Offset results combination 1 testing 2 (50s NU)

| Position Length IC | The Number of Length | Measurement per Sample Checked |      |      |      |      |      |
|--------------------|----------------------|--------------------------------|------|------|------|------|------|
|                    |                      | 1                              | 2    | 3    | 4    | 5    | 6    |
| Right              | 1                    | 0,00                           | 0,00 | 0,04 | 0,04 | 0,00 | 0,02 |
|                    | 2                    | 0,00                           | 0,02 | 0,04 | 0,04 | 0,00 | 0,02 |
|                    | 3                    | 0,00                           | 0,00 | 0,06 | 0,04 | 0,00 | 0,00 |
|                    | 4                    | 0,00                           | 0,02 | 0,06 | 0,04 | 0,00 | 0,00 |
|                    | 5                    | 0,00                           | 0,02 | 0,06 | 0,04 | 0,00 | 0,00 |
|                    | 6                    | 0,00                           | 0,00 | 0,06 | 0,04 | 0,00 | 0,02 |
|                    | 7                    | 0,00                           | 0,00 | 0,06 | 0,04 | 0,00 | 0,00 |
|                    | 8                    | 0,00                           | 0,00 | 0,06 | 0,04 | 0,00 | 0,00 |
| Left               | 1                    | 0,00                           | 0,00 | 0,03 | 0,04 | 0,00 | 0,00 |
|                    | 2                    | 0,00                           | 0,00 | 0,03 | 0,00 | 0,00 | 0,03 |
|                    | 3                    | 0,00                           | 0,00 | 0,03 | 0,00 | 0,00 | 0,02 |
|                    | 4                    | 0,00                           | 0,00 | 0,03 | 0,00 | 0,00 | 0,03 |
|                    | 5                    | 0,00                           | 0,00 | 0,03 | 0,00 | 0,00 | 0,02 |
|                    | 6                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,03 |
|                    | 7                    | 0,00                           | 0,00 | 0,03 | 0,03 | 0,00 | 0,03 |
|                    | 8                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,03 |
| Top                | 1                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 2                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 3                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 4                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 5                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 6                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 7                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 8                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Bottom             | 1                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 2                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 3                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 4                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 5                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 6                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 7                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 8                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |

Data on offset inspection results can be seen in table 5-16.

Table 5. Offset results combination 1 testing 1 (50s NU)

| Position Length IC | The Number of Length | Measurement per Sample Checked |      |      |      |      |      |
|--------------------|----------------------|--------------------------------|------|------|------|------|------|
|                    |                      | 1                              | 2    | 3    | 4    | 5    | 6    |
| Right              | 1                    | 0,00                           | 0,03 | 0,04 | 0,05 | 0,00 | 0,04 |
|                    | 2                    | 0,00                           | 0,03 | 0,04 | 0,05 | 0,00 | 0,05 |
|                    | 3                    | 0,00                           | 0,00 | 0,02 | 0,05 | 0,00 | 0,00 |
|                    | 4                    | 0,00                           | 0,03 | 0,03 | 0,05 | 0,00 | 0,04 |
|                    | 5                    | 0,00                           | 0,00 | 0,02 | 0,05 | 0,00 | 0,00 |
|                    | 6                    | 0,00                           | 0,00 | 0,02 | 0,05 | 0,00 | 0,04 |
|                    | 7                    | 0,00                           | 0,03 | 0,04 | 0,05 | 0,00 | 0,00 |
|                    | 8                    | 0,00                           | 0,03 | 0,02 | 0,05 | 0,00 | 0,00 |
| Left               | 1                    | 0,00                           | 0,00 | 0,02 | 0,05 | 0,00 | 0,00 |
|                    | 2                    | 0,00                           | 0,00 | 0,02 | 0,04 | 0,00 | 0,00 |
|                    | 3                    | 0,00                           | 0,00 | 0,02 | 0,05 | 0,00 | 0,00 |
|                    | 4                    | 0,00                           | 0,00 | 0,02 | 0,04 | 0,00 | 0,00 |
|                    | 5                    | 0,00                           | 0,00 | 0,02 | 0,07 | 0,00 | 0,00 |
|                    | 6                    | 0,00                           | 0,00 | 0,00 | 0,04 | 0,00 | 0,00 |
|                    | 7                    | 0,00                           | 0,00 | 0,04 | 0,09 | 0,00 | 0,00 |
|                    | 8                    | 0,00                           | 0,00 | 0,00 | 0,05 | 0,00 | 0,00 |
| Top                | 1                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 2                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 3                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 4                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 5                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 6                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 7                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 8                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Bottom             | 1                    | 0,00                           | 0,07 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 2                    | 0,00                           | 0,09 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 3                    | 0,00                           | 0,09 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 4                    | 0,00                           | 0,09 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 5                    | 0,00                           | 0,08 | 0,00 | 0,00 | 0,00 | 0,03 |
|                    | 6                    | 0,00                           | 0,09 | 0,00 | 0,00 | 0,00 | 0,03 |
|                    | 7                    | 0,00                           | 0,09 | 0,00 | 0,00 | 0,00 | 0,03 |
|                    | 8                    | 0,00                           | 0,09 | 0,00 | 0,00 | 0,00 | 0,02 |

Table 7. Offset results combination 1 testing 3 (50s NU)

| Position Length IC | The Number of Length | Measurement per Sample Checked |      |      |      |      |      |
|--------------------|----------------------|--------------------------------|------|------|------|------|------|
|                    |                      | 1                              | 2    | 3    | 4    | 5    | 6    |
| Right              | 1                    | 0,00                           | 0,03 | 0,04 | 0,00 | 0,00 | 0,08 |
|                    | 2                    | 0,00                           | 0,03 | 0,03 | 0,00 | 0,00 | 0,08 |
|                    | 3                    | 0,00                           | 0,03 | 0,03 | 0,00 | 0,00 | 0,00 |
|                    | 4                    | 0,00                           | 0,03 | 0,03 | 0,00 | 0,00 | 0,00 |
|                    | 5                    | 0,00                           | 0,03 | 0,03 | 0,00 | 0,00 | 0,00 |
|                    | 6                    | 0,00                           | 0,00 | 0,03 | 0,00 | 0,00 | 0,00 |
|                    | 7                    | 0,00                           | 0,03 | 0,04 | 0,00 | 0,00 | 0,00 |
|                    | 8                    | 0,00                           | 0,02 | 0,03 | 0,00 | 0,00 | 0,00 |
| Left               | 1                    | 0,00                           | 0,02 | 0,08 | 0,00 | 0,00 | 0,03 |
|                    | 2                    | 0,00                           | 0,02 | 0,04 | 0,00 | 0,00 | 0,09 |
|                    | 3                    | 0,00                           | 0,02 | 0,02 | 0,00 | 0,00 | 0,03 |
|                    | 4                    | 0,00                           | 0,02 | 0,02 | 0,00 | 0,00 | 0,04 |
|                    | 5                    | 0,00                           | 0,02 | 0,02 | 0,00 | 0,00 | 0,02 |
|                    | 6                    | 0,00                           | 0,02 | 0,02 | 0,00 | 0,00 | 0,04 |
|                    | 7                    | 0,00                           | 0,02 | 0,04 | 0,00 | 0,00 | 0,04 |
|                    | 8                    | 0,00                           | 0,02 | 0,02 | 0,00 | 0,00 | 0,04 |
| Top                | 1                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 2                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 3                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 4                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 5                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 6                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 7                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 8                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Bottom             | 1                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 2                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 3                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 4                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 5                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 6                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 7                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 8                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |





Table 16. Offset results combination 4 testing 3 (150s M)

| Position Length IC | The Number of Length | Measurement per Sample Checked |      |      |      |      |      |
|--------------------|----------------------|--------------------------------|------|------|------|------|------|
|                    |                      | 1                              | 2    | 3    | 4    | 5    | 6    |
| Right              | 1                    | 0,03                           | 0,02 | 0,05 | 0,00 | 0,00 | 0,00 |
|                    | 2                    | 0,02                           | 0,00 | 0,02 | 0,00 | 0,00 | 0,00 |
|                    | 3                    | 0,03                           | 0,00 | 0,03 | 0,00 | 0,00 | 0,00 |
|                    | 4                    | 0,03                           | 0,00 | 0,04 | 0,00 | 0,00 | 0,00 |
|                    | 5                    | 0,04                           | 0,02 | 0,05 | 0,00 | 0,00 | 0,00 |
|                    | 6                    | 0,03                           | 0,00 | 0,04 | 0,00 | 0,00 | 0,00 |
|                    | 7                    | 0,04                           | 0,02 | 0,04 | 0,00 | 0,00 | 0,00 |
|                    | 8                    | 0,04                           | 0,00 | 0,02 | 0,00 | 0,00 | 0,00 |
| Left               | 1                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 2                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,03 |
|                    | 3                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 4                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 5                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 6                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 7                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 8                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Top                | 1                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 2                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 3                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 4                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 5                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 6                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 7                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 8                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| Bottom             | 1                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 2                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 3                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 4                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 5                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 6                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 7                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
|                    | 8                    | 0,00                           | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |

The aim of this experiment is to obtain optimal process parameter settings on a pick and place machine, especially for IC 32 QFP components. Where the response to the accuracy of component placement is based on the condition "the smaller the deviation/offset value of the pad, indicating better dimensional accuracy in the experiment."

Based on the offset measurement results in table 2-13, the following graph is obtained.

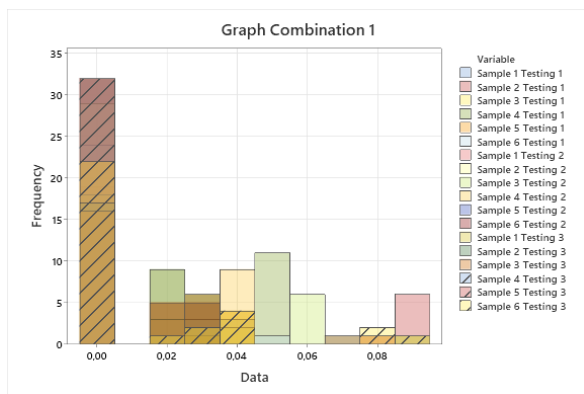


Figure 6. Graph combination 1 (50s Not use)

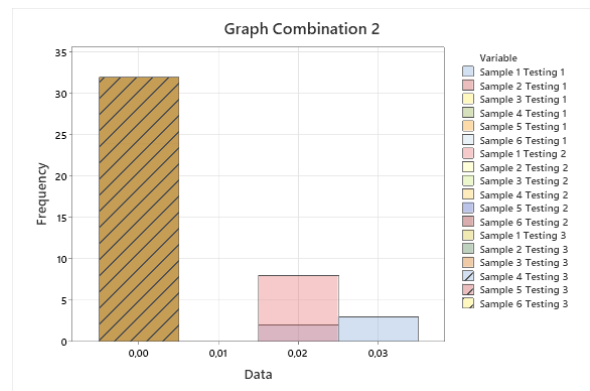


Figure 7. Graph combination 2 (50s Mount)

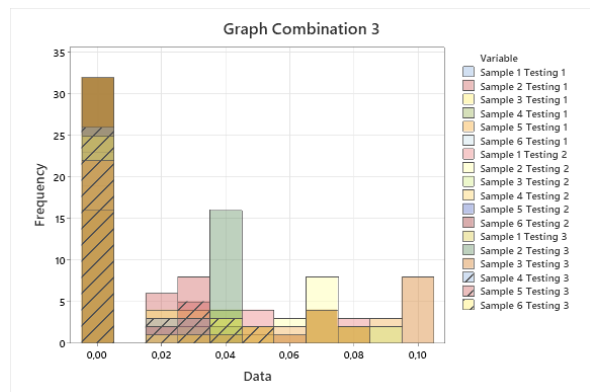


Figure 8. Graph combination 3 (150s Not use)

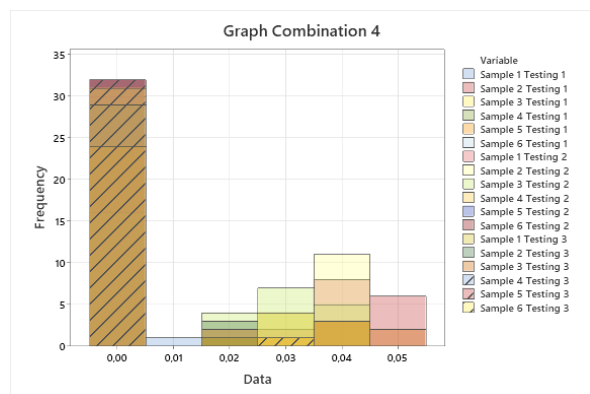
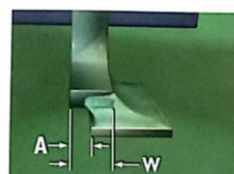


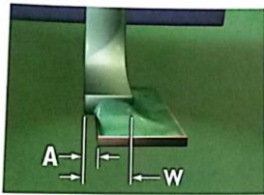
Figure 9. Graph combination 4 (150s Mount)

Quoting from IPC A-610 as a standard reference for laying IC gull wing components, it is written that the maximum side overhang standard for flat gull wing lead components is:



Class 1 and class 2 : not greater than 50% lead width (W) or 0.5 mm [0.02 in] , whichever is less.

Figure 10. IPC A-610



Class 3 : not greater than 25% lead width (W) or 0.5 mm [0.02 in], whichever is less.

Figure 11. IPC A-610

This means that for classes 1 and 2 the maximum overhang allowed is no more than 50% of the component lead width. Based on the IC 32 QFP datasheet, the width of the component lead is min. 0.30 mm and max. 0.45mm. Meanwhile, the width of the lead component set on the pick and place machine is 0.35 mm. From this width, the maximum standard overhang for class 1 and 2 is 0.175 mm and the maximum standard overhang for class 3 is 0.087 mm.

Judging from the graph in figure 6, for the experiment with a pick up time parameter of 50s and not using soft touch, there are many offsets and there are even offset values that exceed the class 3 limit. The graph in figure 7 is with a pick up time parameter of 50s and uses soft touch." Mount" shows that less offset occurs and the offset value does not exceed the class 3 limit. The graph in figure 8 with a pick up time parameter of 150s and does not use soft touch, shows that a lot of offset occurs, even the offset value exceeds the class 3 limit. Graph in the 9th image with a pick up time parameter of 150s and using the soft touch "Mount", it shows quite a lot of offset occurring but the offset value does not exceed the class 3 limit.

### Comparison Data

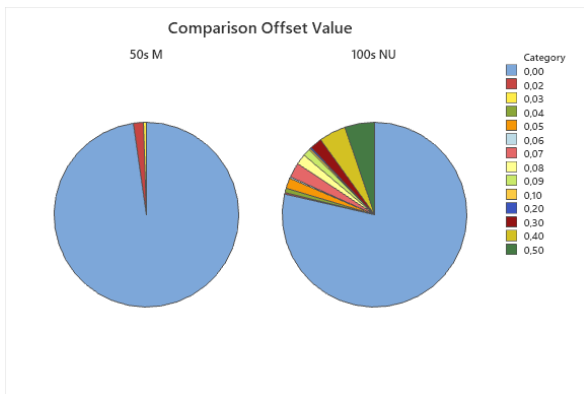


Figure 12. Comparison offset value 50 M and 100 NU

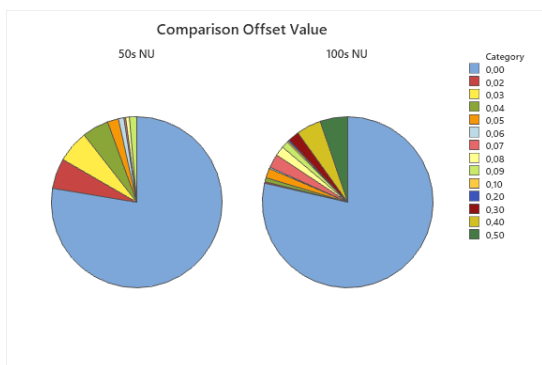


Figure 13. Comparison offset value 50s NU and 100s NU

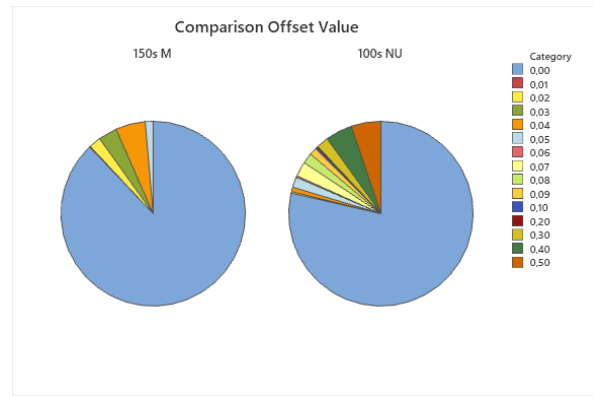


Figure 14. Comparison offset value 150s M and 100s NU

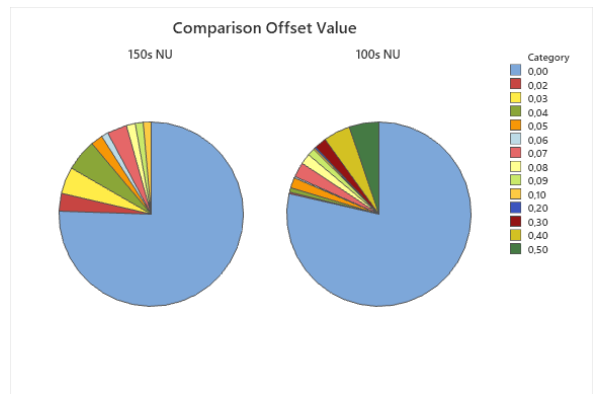
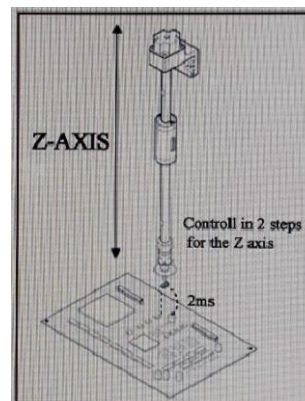


Figure 15. Comparison offset value 150s NU and 100s NU

Figures 12-15 are the offset comparison charts before optimization and after optimization. Before the optimization process, the parameters used are the default parameters of the pick and place machine, namely with a pick up delay time of 100s and soft touch is not active (not used). From the comparison of the 100s NU parameter (before optimization) with all optimization combinations, there is one combination that has the least offset, namely combination 2 with the 50s Mount parameter. This happens because of the influence of using the soft touch parameter.

The soft touch parameter is a very important role in this experiment. Soft touch is a parameter that will ensure the process of picking and placing components in the right position. So when this parameter is enabled, the speed of the Z axis to become 4 (slow) at 2 mm height from the PCB upper surface when the head moves down regardless of the speed set in the <Speed> group.



In this research, soft touch is used only for the placement component. As you can see from the experimental results in figure 7 and figure 9, there are not many offsets that exceed the standard. So, it's possible that there is less offset when activating the soft touch (mount).

#### 4. Conclusions

From all the experiments that have been carried out, the optimal parameters with the smallest offset for the 32 QFP IC component are obtained by setting the pick up delay time of 50s and using the soft touch "mount". The purpose of this optimization is to improve the quality so that the results obtained meet the IPC A-610 class 1, 2 and 3 standards.

#### Acknowledgment

The researcher would like to thank TFME Batam State Polytechnic for supporting the research facilities and infrastructure so that the researcher and carried out this project and completed it as expected.

#### References

- [1] R. A. P. E. Maulana, "Pemanfaatan Layanan SMS Telepon Seluler Berbasis Mikrokontroler Atmega328p Sebagai Sistem Kontrol Lampu Rumah," *JURNAL TEKNIK KOMPUTER AMIK BSI*, vol. III, no. 1, pp. 93-99, 2017.
- [2] I. P. H. Y. S. P. D. W. Shun Cao, "Prediction of Component Shifts in Pick and Place Process of Surface Mount," *Procedia Manufacturing*, vol. 39, pp. 210-217, 2019.
- [3] Z. Z. D. W. S. Y. Y. J. Jaewoo Kim, "A Pick-and-Place Process Control Based on the Bootstrapping Method for Quality Enhancement in Surface Mount Technology," New York, 2023.
- [4] G. R. Blackwell, "Surface Mount Technology," in *Electronic Systems Maintenance Handbook*, Boca Raton, CRC Press, 2017, pp. 12-1.
- [5] S. O'Neill, *Optimisation of a Surface Mount Technology Process Using a SnAgCu Lead-Free Alloy*, Sligo: Institute of Technology, 2005.
- [6] A. R. Pratama, *Optimalisasi Keselamatan Crew Kapal dalam Proses*, Semarang, 2013.
- [7] S. S. Rao, *Engineering Optimization: Practice and Theory*, Wiley, 2009.
- [8] H. H. P. S. H. A. Permana, "Design of Experiment (DOE) Analysis with Response Surface Method (RSM) to Optimize the Electroplating Parameter," *Computer, Mathematics and Engineering Applications*, vol. XII, no. 2, pp. 99-109, 2021.
- [9] G. K. M. Ayob, "A Survey of Surface Mount Device Placement Machine Optimisation: Machine Classification," *European Journal of Operational Research*, vol. CLXXXVI, no. 3, pp. 893-914, 2008.
- [10] *Acceptability of Electronic Assemblies-Revision H*,