CLAMPER BUY OFF ANALYSIS AND STORAGE MANAGEMENT AT THE WIRE BONDING PROCESS

Final Project

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Statement of Authenticity of Final Project

I am the person who is signed declare that the contents of part or all of my Final Project entitled: **"Clamper Buyoff Analysis and Storage Mangement at the Wire Bonding Process"** is my own work, completed without the use of unauthorised materials, and is not the work of others that I acknowledge as my own. All references quoted 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 according to applicable regulations.

Batam, 23 July 2024

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Validity Sheet

The Final Project is structured of fulfill one of the requirements for Bachelor of Associate Engineer (AMd.T.)
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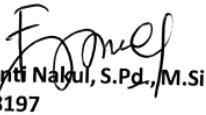

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Clamper Buy Off Analysis and Storage Management at the Wire Bonding Process

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***Abstract*—Wire bonding is the process of making interconnections between metallized bond pads with leads or other semiconductor devices with conducting wires. Inside the wire bonding machine there are various tools such as Clamper, which functions as a main frame holder during the bonding process. Before the clamper is used, it is necessary to purchase the clamper first, the purpose is to find out whether the clamper is according to standard or not and when the machine is running the technician can find out the problems associated with the clamper. The clamper will be tested and inspected both visually and testing, and from the results of the inspection a conclusion can be drawn about the clamper and the test data will be analyzed using the Box Plot method. Then, because there are many types of clampers with various packages in the Development Department that are not managed, for example where the clamper is stored, the current position of the clamper, its physical form and identity, it is necessary to make management to unite all data related to the clamper. This management method is in the form of database collection, then processed in excel software in the form of a system that is expected to facilitate users in the Development Department in finding information, storage and management of clamper inventory to be used.**

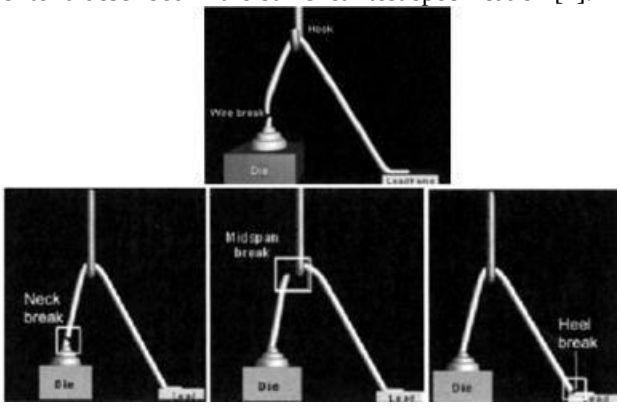
Keyword: Wire Bonding, Clamper Buyoff, Clamper Management

I. INTRODUCTION

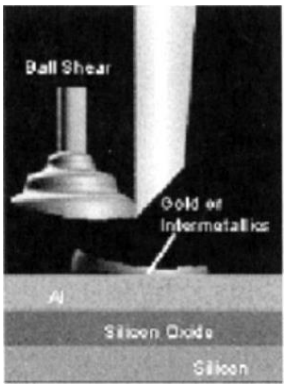
Integrated circuit are indispensable core component in electronic products such as mobile phones, smart watches, computers and intelligent robots and IC packaging is one of the important factors [1]. Wire bonding is an interconnection technique where two metallic material, a wire and bond pad, are bonded using a combination of temperature, force, ultrasonic power, and time. There are three wire bonding technologies namely thermocompression bonding, ultrasonic bonding, and thermosonic bonding [2].

Inside the wire bonding machine there are various tools, for example Clamper tool, the Clamper consists of an arrangement of several Wire bonding parts with corresponding holes and is designed according to the relative position of the Semiconductor die to be wire bonded. The clamper holds the radius from the main frame to the Heat Block to allow wire bonding interconnections to be made between the main frame and the Integrated Circuit (IC) components [3].

This research is based on two background problems, first, there is a new Integrated Circuit (IC) package at Infineon Batam, so it is necessary to analyze the clamper first to find out which clamper with the new package will be used according to the standard. To analyze the bond quality after the purchase of mechanical clamper-kit, it is necessary to test the wire pull and ball shear are two significant quality characteristics used to evaluate the wire bond quality. In view of this, a means to assist IC Packaging company in the assessment of wire bond quality is an important topic [4]. The wire pull test is used to measure the strength failure mode of the wire bond. Generally, if the hook is placed at the mid span of the wire then the test will show the weakest link of the bond. This is typically either the neck of the ball bond (right above the ball) or at the heel of the wedge bond. Pull test is a destructive test and it's a statistical process control monitor at all of National Semiconductor's Assembly sites [5]. Ball shear test is another method for evaluating the quality of a ball bond. The bond strength and failure mode are measures of the ball bond quality. Ball shear data reflects the intermetalic formation and its coverage of the bonds [6]. During testing this tool pushes the ball bond with a sufficient force. Positioning of the tool is very important during shear testing. The shear ram is positioned just above the bond pad such that the bottom of the shear tool is close to the centre of the ball. The shear to to moves parallel to the bonded surface and shears the ball bond. The improper positioning of the tool is one of most common problem in shear test. During the ball shear test the shearing ram needs to be positioned exactly according to criteria described in the ball shear test specification [7].



(a)



(b)

Figure 1. (a) Bond Pull Test and (b) Bond Shear Test

Then to analyze the test data is to study the characteristics of the data. For that we need to know for example the centering and spread of the data from the mean, extreme values or outliers and some other measurements. Box plot is a graphically presented summary of the sample distribution that can describe the shape of the data distribution (skewness), a measure of central tendency and a measure of spread (diversity) of the observed data [8]. The box plot is one of a diverse family of statistical techniques, called exploratory data analysis, used to visually identify patterns that may otherwise be hidden in a datashet [9].

Second, there are many variations of packages at Infineon Batam with different clampers, so that clampers that are not systematized, for example storage places, number of items, current location and so on can interfere with the process so that it requires systematic management to facilitate its users. According to (Muflihin et al., 2020), a company engaged in sales and purchases must have an inventory information system in order to manage data effectively and efficiently so that data on the availability of goods becomes very important. The existence of problems in this background is a context where the inventory system or availability of goods is an important thing that must be considered in running a business. The method created must make work simpler in terms of managing inventory, making it more efficient and effective in management [10].

Therefore, the author needs to conduct buyoff and analysis to find out the clamper for this new package type and perform clamper management in the form of collecting clamper information in the Development Department and making it a database for management, labeling, and storage management as well as a usage inventory system that can facilitate users in the Wire Bonding process area.

For the use of Clamper-kit, an inventory management system is required, this simple inventory system is created using Excel Software in Visual Basic for with Plug In Developer. Where, users must fill in the page on this system when they want to borrow or return the Clamper-kit used.

II. METHOD

A. Clamper Design

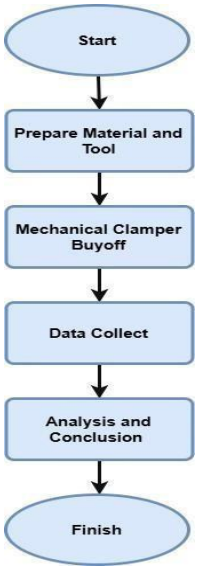


Figure 2. Flowchart Clamper Buyoff

The first step is to prepare the tools and materials needed for the research, such as clamper, capillary, leadframe, pressure paper and digital thermometer. Then perform mechanical buyoff Clamper in UTC 5000 Shinkawa machine by converting Clamper-Kit which consists of lead clamper, paddle adapter and heater spacer. Various checks and tests will be carried out at this stage. After the mechanical buyoff Clamper-Kit is carried out, it will be continued with Test and Measurement to collect data that will be analyzed for bonding quality results and finally draw conclusions from the buyoff Clamper-Kit test results that have been carried out.

After the Buyoff clamps, the existing clamps in the Development Department will be managed to facilitate their use. The first step is to record all existing clamps. Then all the data will be created into a database in excel. Then, summarizing the Clamper storage boxes in one box that previously from the place of purchase were in different places and labeling each box according to its packaging.

Finally, managing the clamper storage and creating a simple inventory system for its use, for an overview of the flow of clamper management can be seen in figure 3:

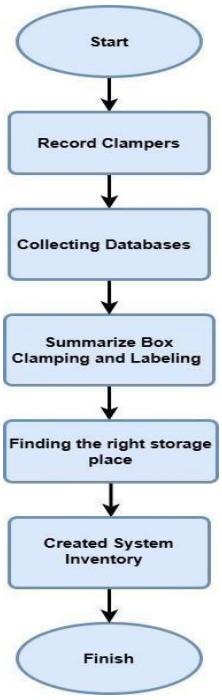


Figure 3. Flowchart Clamper Management

B. *Tools and Material*

Table 1. Tools and Material List

No.	Tools	Qty	Material	Qty
1	UTC5000 Shinkawa machine	1	Lead frame	3 strip
2	Hisomet machine	1	Pressure Paper	as needed
3	Dage series 4000 machine	1	Copper Wire	1 spool
4	Clamper-kit LDSO 8-1 Package	3 set	Capillary	1 pcs
5	Thermometer digital	1		
6	Microscope low power	1		

1. Tools

a. UTC5K Machine
There are several machines in the Wire Bonding Process at Infineon Batam, namely ASM, ALU, and Shinkawa. In this study used the UTC5K Shinkawa Machine.

b. Dage Machine
For destructive testing, researchers used the Dage Machine series 4000 for the Wire Pull test and Ball Shear Test.

c. Hisomet Machine
To take measurements on the bond samples, the researchers used a Union brand Hisomet machine to take measurements of the dimensions of the ball, stitch length, stitch width, and loop height using 40x magnification.

d. Clamper
The clamp used in this study uses Shinkawa's LDSO 8-1 Package (New Package).

e. Thermometer analog
A thermometer is used to support the temperature checking process during clamper buy-off.

f. Microscope
A microscope is used to perform a visual inspection of the leadframe that has been wire bonded. The microscope used is a digital microscope without magnification, but uses zoom in and zoom out, ranging from 0.67 to 4.5X zoom-in.

2. Material

a. Leadframe
To work on this project the author needs a sample. In this project using Leadframe with dimensions of 62cm width and 250cm long with Package type LDSO 8-1 and with the number of units in one Strip is 200 units consisting of 20 columns and 10 rows.

b. Wire
In this study, researchers used 30 micron (um) diameter Copper Wire

c. Capillary
The tool for forming Ball Bonding is called a Capillary. A capillary is a ceramic material used as a wire channel for bonding from chips to leads.
Use KNS Capillary for 30um copper wire.

d. Pressure Paper
As a medium to see the flatness of the tin clamp, whether it clamps the frame evenly or not.

C. *Test*

1. Mechanical Clamper Buyoff

The Clamper Buyoff step consists of several test and inspection steps, as shown in table 2.

Table 2. Mechanical Buyoff Steps

No	Requirement	Result (Pass/ Fail)
1	Visual check and labelling check	
2	Pressure Paper Check	
3	Temperature Check	
4	Paddle Planarity Check	
5	Alignment Check	
6	Unit Pitch Check	
7	Die Pad Bouncing Check	
8	Die Pad Lateral Move Check	
9	Lead Bouncing Check	
10	Vacuum Check	
11	Oxidation Check	
12	FAB Oxidation Check	
13	Bonding Quality Check	

2. Wire Bonding Process

After purchasing the mechanical clamper, the first wire bonding process was carried out for the Bonding Quality Check, which is to see the results of the wire bonding, whether there are any problems related to the clamper-kit.
The following are the parameters used for the wire bonding process, as shown in the table 3.

Table 3. Parameters of the Wire Bonding Package LDSO 8-1

Parameters	1st bond			2nd bond	
	Setting	Range	Bump bond	Setting	Range
Force	28.0gf	25-31gf	28gf	135.0gf	127-142gf
Power	455	450-460	450	180	160-200
Times	11.0ms	9-13	11.0ms	12.0ms	11-13ms

3. Data Collection

After the mechanical buyoff of the Clamper-kit and the wire bonding process on Package LDSO 8-1, the data was collected for analysis. The data collection method uses Destructive test and Non Destructive test, as described below:

- For the Destructive Test method measurements using the Dage 4000 series machine include: Ball Pull, Stitch Pull, Ball Shear, and Bump Shear.
- For Non Destructive Test method measurements using the Hisomet machine, measurements include: Ball dimension (X,Y,Z), Loop Height, Stitch Width, and Bump Dimension (X,Y,Z).

Table 4. Specification Measurement Parameters of Destructive Test

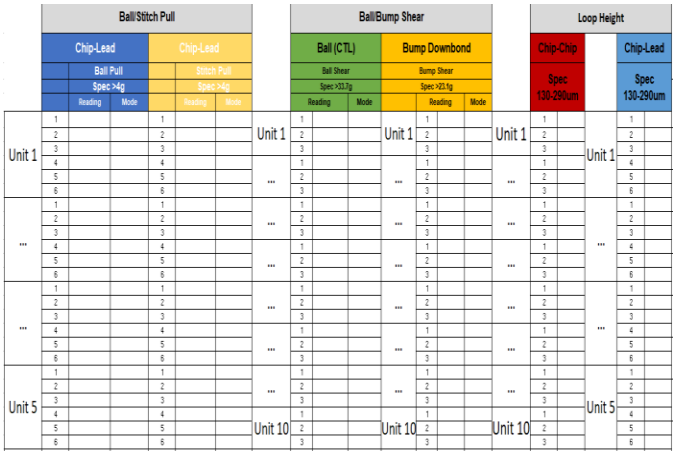
Wire Diameter	Measurement	Specification	Sample Test
CU 30 µm	Ball Pull	>4g	30 Reading
	Stitch Pull	>4g	30 Reading
	Ball Shear	>33.7g	30 Reading

Table 5. Specification Measurement Parameters of Non Destructive Test

Wire Diameter	Measurement	Specification	Sample Test
CU 30 µm	Ball dimension	65-85 µm	30 Reading
	Bump dimension	75-105 µm	30 Reading
	Loop Height	130-290 µm	30 Reading
	Stitch Lenght	15-90 µm	30 Reading
	Stitch Widht	36-150 µm	30 Reading
	Ball Height	20-36 µm	30 Reading
	Bump Height	35-70 µm	30 Reading

Table 6. Data Collection Table Result

Ball/Bump Dimension Measurement							
Ball (C11HV-CTR)					Security Bond (Bottom Bump)		
Spec 65-85um			20-36um		Spec 75-105um		
	Size (X)	Size (Y)	Height			Size (X)	Size (Y)
1					1		
2				Unit 1	2		
3					3		
4					1		
5				Unit 2	2		
6					3		
7					1		
8				Unit 3	2		
9					3		
10					1		
11				Unit 4	2		
12					3		
13					1		
14				Unit 5	2		
15					3		
16					1		
17				Unit 6	2		
18					3		
19					1		
20				Unit 7	2		
21					3		
22					1		
23				Unit 8	2		
24					3		
25					1		
26				Unit 9	2		
27					3		
28					1		
29				Unit 10	2		
30					3		



4. Database Collection Method for Storage Management

To improvise the management and storage of clamper-kits in the Development Department, researchers collected all clamper-kit data to create a database using excel and recorded all clampers in the excel file, then labeled the clampers and organized their storage for user ease. Finally, researchers created a Clamper Inventory System for incoming and outgoing goods data so that clamper information can be updated continuously.

Table 7. Clamper list table

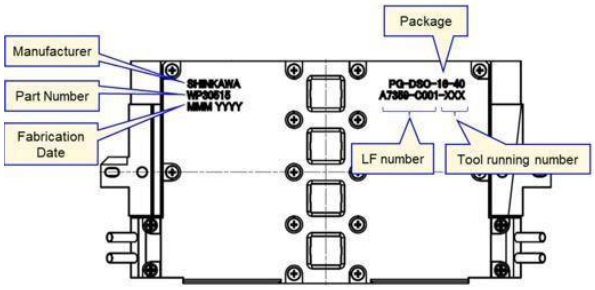
Record Clamper Data in Development Department					
LF size	Package	UTC5K C-kit	Part Number	Labeling	Remark
		Lead Clamper			
		Paddle Adaptor			
		Heat Spacer			
LF size	Package	UTC5K C-kit	Part Number	Labeling	Remark
		Lead Clamper			
		Paddle Adaptor			
		Heat Spacer			
LF size	Package	UTC5K C-kit	Part Number	Labeling	Remark
		Lead Clamper			
		Paddle Adaptor			
		Heat Spacer			

III. Result and Discussion

A. *Clamper Mechanical Buyoff Result*

1. Visual check and Labelling check

Visually check the condition of the new C-Kit, whether there are defects or not and match the design as requested.



Lead clamper

Engrave Position A	Engrave Position B
SHINKAWA	PG-LDSO-8-1
WP30737	A7468-C005-002
OCT 2023	

Paddle Adaptor

Engrave Position A	Engrave Position B
SHINKAWA	PG-LDSO-8-1
HP30737	A7468-C005-002
OCT 2023	

Heater Spacer

Engrave Position A	Engrave Position B
SHINKAWA	PG-LDSO-8-1
AD77014	A7468-C005-002
OCT 2023	

Figure 4. Clamper-kit Engraving Information

A visual check of the Clamper-kit, which consisted of checking the physical condition and accuracy of the labeling, found no labeling faults and no defects in the physical condition of the Clamper-kit.

Table 8. Visual Check Result

C-Kit check		Result
 Lead clamp (Top)	 Lead clamp (Bottom)	Pass
 Paddle Adaptor	 Heat Spacer	Pass

2. Pressure Paper check

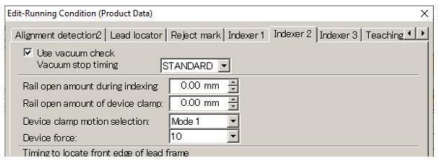
It is a step taken to see the flatness of the surface between the paddle and lead clamp by using a pressing paper placed between the paddle & lead clamper.

For the settings:

- Heater temperature : OFF
- Set Device Force : 10
- Clamped for 1-2 minutes

The test results passed, it can be seen that the paddle clamping marks with the lead clamp are formed in 1 column, where a total of ten rows have the same mark, meaning that each unit in 1 column has the same levelness.

Table 9. Pressure paper check result

Machine Setting	Result
	 Pass

3. Temperature check

This is the stage of checking the temperature on the C-Kit whether the heat supplied is in accordance with the specifications using a digital thermometer.

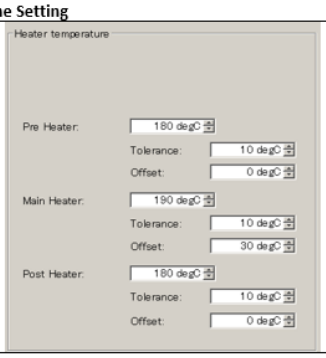
For this LDSO 8-1 package, checking the temperature consists of several settings on the machine, namely:

- Heater ON temperature setting: 190 degrees Celsius
- Performing LEAD ON bonding level: 900 ± 50
- The result temperature / temperature checking requirements on the bare lead frame 190 ± 5 ° C.

The checking locations are on the top, middle and last row, for the measurement results can be seen in the figure below, where the measurement results are in the specifications that have been determined, the measurement results representing each row (top, middle, bottom), are in the range of specifications = 190 ± 5 with a range of 6.5 degrees Celsius, meaning that the temperature measurement results pass.

Table 10. Temperature check result

Machine Setting



Result

Row	Temperature (deg°)
Row 1	186.5
Row 5	193.0
Row 10	187.0
Range	6.5degC

Pass

4. Paddle Planarity check

It is a level check on the paddles in each unit in 1 column. The result of checking the bond level of each row on the paddle, where the highest result is reduced by the lowest levelness result, the result is 5.8 um, meaning that after

checking, the levels of each unit are Pass, with perfect setup requirements: <50um.

Table 11. Paddle Planarity check result

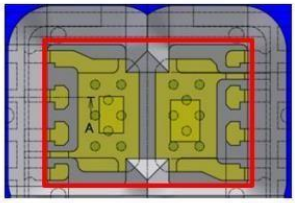
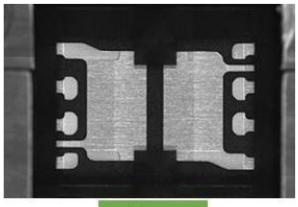
	Bond Level
Row 1	691.1
Row 2	692.6
Row 3	694.5
Row 4	695.9
Row 5	695.7
Row 6	694.5
Row 7	695.5
Row 8	696.9
Row 9	693.6
Row 10	693.9
Range	5.8 µm

Pass

5. Alignm

This check is carried out to ensure the Clamper-kit installation conditions are in accordance with the requirements, the Clamper-Kit installation is adjusted and the setup results as seen in the picture below. It can be seen that the left and right, top and bottom positions of the clamper-kit are balanced and appropriate between the clamper and the leadframe, and the installation results shown have followed the requirements with a pass result.

Table 12. Alignment Check

Requirment	Result
	 Pass

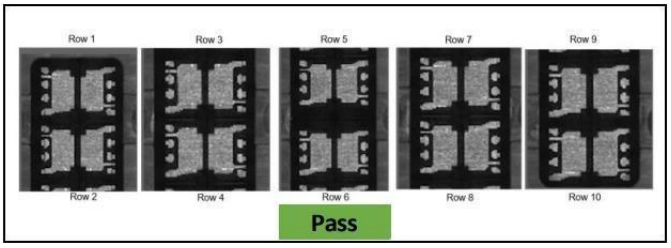
6. Unit Pitch Check

Is a check of the similarity of each unit in 1 column when the clamper clamps the leadrame, where the top of the unit & the bottom of the unit must be uniform in position / aligned. The settings consist of:

- Heater temperature : 190 degC
- Make sure all 10 rows + are evenly aligned.
- The tolerance requirement is ±100um.

For the checking results can be seen as shown below, where the distance between the first unit and the last unit is the same, meaning the result of checking the unit pitch is Pass.

Table 13. Unit Pitch check result

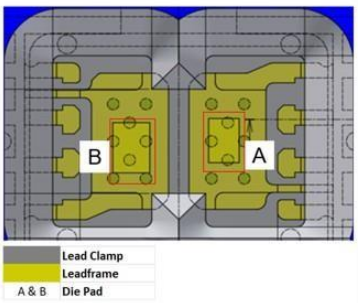


7. Die Pad Bouncing Check

Performed to confirm whether there is an up (Z direction) bounce on the die pad. The image below shows the die pad bounce check locations marked with A & B and the test results as follows.

Table 14. Die Pad Bouncing Check

Location



Result

Row	Die Pad	Bouncing Check
Row1	A	Passed
	B	Passed
Row2	A	Passed
	B	Passed
Row3	A	Passed
	B	Passed
Row4	A	Passed
	B	Passed
Row5	A	Passed
	B	Passed
Row6	A	Passed
	B	Passed
Row7	A	Passed
	B	Passed
Row8	A	Passed
	B	Passed
Row9	A	Passed
	B	Passed
Row 10	A	Passed
	B	Passed

Status	Result
	Bouncing/Failed
	Minor Bouncing/Failed
	No Bouncing/Passed

The image above shows the bounce results of the die pad tested by manual check. All units checked, there was no bounce. So, the mechanical buyoff clamp is accurate / passing.

8. Die Pad Lateral Move Check

In checking the lateral movement of the die pad, it is done by moving the die pad in the X and Y directions. For the test results, no movement was found on the pad, so the result of checking the lateral movement of the die pad is Pass.

Table 15. Die Pad Lateral Move Check

Method	Documentation	Result
		

ROW	Die Pad	Lateral Move Check
ROW 1	A	PASSED
	B	PASSED
ROW 2	A	PASSED
	B	PASSED
ROW 3	A	PASSED
	B	PASSED
ROW 4	A	PASSED
	B	PASSED
ROW 5	A	PASSED
	B	PASSED
ROW 6	A	PASSED
	B	PASSED
ROW 7	A	PASSED
	B	PASSED
ROW 8	A	PASSED
	B	PASSED
ROW 9	A	PASSED
	B	PASSED
ROW 10	A	PASSED
	B	PASSED

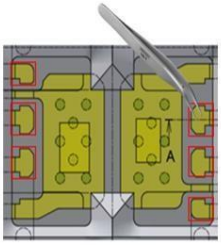
Status	Result
	Move lateral/Failed
	Minor Move Lateral/Failed
	No Move Lateral/Passed

9. Lead Bouncing Check

Checking the lead bounce is carried out on any lead in the area marked with a red line as in the image below, the result of the lead bounce test is that no leads are found that experienced a bounce when the test was carried out, meaning that the result of this test is a pass.

Table 16. Lead Bouncing Check

Method	Documentation	Result



Row	Lead Bouncing Check
Row 1	Passed
Row 2	Passed
Row 3	Passed
Row 4	Passed
Row 5	Passed
Row6	Passed
Row 7	Passed
Row 8	Passed
Row 9	Passed
Row 10	Passed

Status	Result
	Bouncing/Failed
	Minor Bouncing/Failed
	No Bouncing/Passed

10. Vacuum check

Checking the vacuum value read on the vacuum meter display. For the requirement for vacuum is: <-80kPa.
The result of the inspection is Pass can be seen in table 17.

Table 17. Vacuum check result

Result
Vacuum Reading -84.0 kPa

Pass

11. Oxidation Test

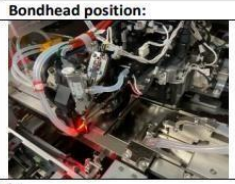
Checks the leadframe color change for any indication of color change when the leadframe is on the indexer track.
For setup, it consists of:

- Use an bare leadframe after plasma for oxidation test.
- Place the leadframe into the bonding area, with a bonding temperature of 190°C, an after-heater of 180°C and leave it in the bonding area for 30 minutes.

The result is that there is no color change in the bare leadframe at the front or back position of the leadframe.

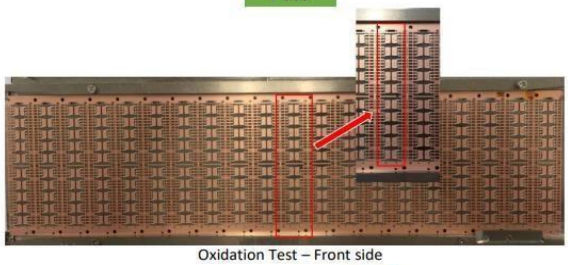
Table 18. Oxidation Test

N2 flow rate setting:	Bondhead position:

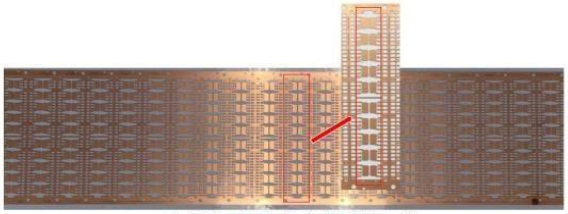


Result:

Pass



Oxidation Test – Front side



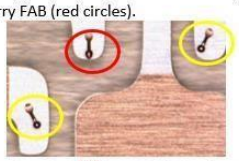
Oxidation Test – Back side (Flipped)

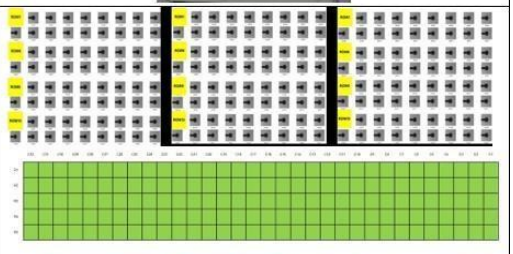
12. Free Air Ball Oxidation Check

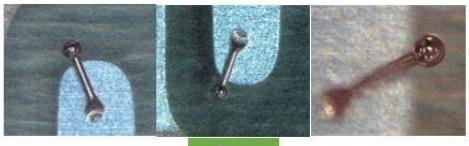
FAB farming on bare lead frame (1 strip) check shape and oxidation. The entire column is given FAB, for the results of the pass check, where no rejects were found in the FAB test such as oxidation or cherry ball, can be seen in the following picture.

Table 19. FAB Oxidation Check

FAB Criteria	a. Good FAB, yaitu FAB must be shining (no oxidized) and FAB must be spherical (yellow circles) b. Reject FAB, yaitu FAB dark karena oksidasi, Ball not circle and Cherry FAB (red circles).
N2 flow rate setting	
Result	





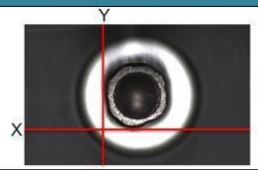
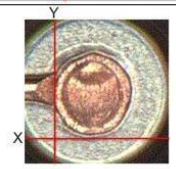
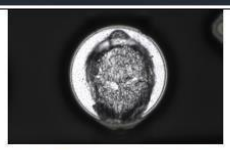
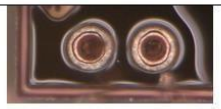
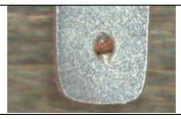


Pass

13. Bonding Quality Check

The last step is to perform the wire bonding process using 1-2 leadframe, then take data to analyze the bonding quality.

Table 20. Bonding Quality Check result

OUTPUT RESPONSES	RESULT	DOCUMENTATIONS
Ball Dimension	Pass	
Bump Dimension	Pass	
Ball Shear	Pass	
Bump Shear	Pass	
Ball Pull	Pass	
Stitch Pull	Pass	

B. Data Collect Result

1. Ball/Stitch Pull Force

Table 21. Descriptive Statistics of Ball Pull test

Statistics

Variable	Total Count	Mean	StDev	Minimum	Q1	Median	Q3	Maximum	Range
Ball Pull CTL	70	18,348	1,016	15,579	17,639	18,510	19,131	20,362	4,783

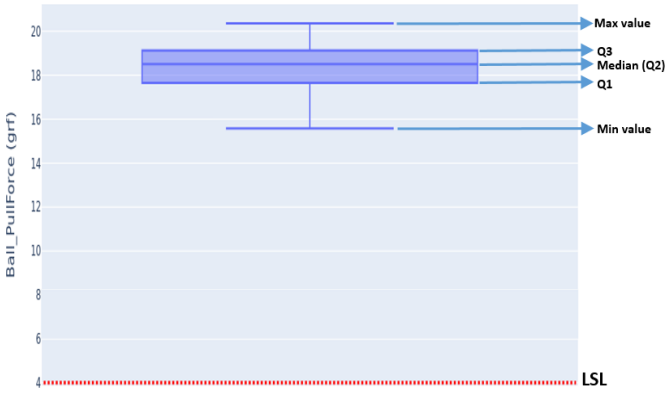


Figure 5. Boxplot of Ball Pull Test

The boxplot above shows the results of the pull test data on the Ball to lead chip, with the Lower Spec Limit (LSL) at a value of 4grf, meaning that the lowest limit of the data is 4grf while the highest limit is not specified. It can be seen that the mean value of the data =18.348, highest quartile (Q3) =19.13, lowest quartile (Q1) =17.63 and Cpk= 4,708. The boxplot does not look wide, this means that there is no significant difference in value between each data value of the ball pull results taken.

Table 22. Descriptive Statistics of Stitch Pull test

Statistics

Variable	Total Count	Mean	StDev	Minimum	Q1	Median	Q3	Maximum	Range
Stitch Pull CTL	70	12,870	0,935	10,606	12,275	12,838	13,447	15,310	4,704

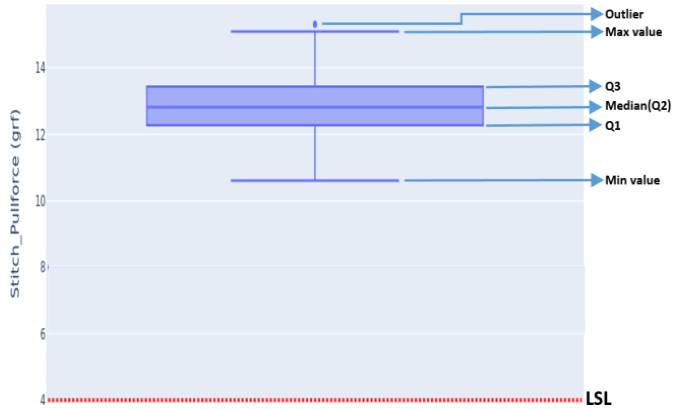


Figure 6. Boxplot of Stitch Pull Test

The boxplot above is data from the stitch pull chip to lead pull test, the Lower spec limit (LSL) specified is 4grf, meaning the data is not acceptable if ≤ the LSL value. The lowest quartile value (Q1) =12.27 and the highest quartile (Q3) =13.44, for this test there is one data value that has a different value (higher) than the other data but is above the LSL and is included in the spec.

2. Ball/Bump Shear Force

Table 23. Descriptive statistics of Ball Shear test

Statistics

Variable	Total Count	Mean	StDev	Minimum	Q1	Median	Q3	Maximum	Range
Ball Shear CTL	70	95,648	6,728	82,270	91,140	94,860	100,688	119,210	36,940

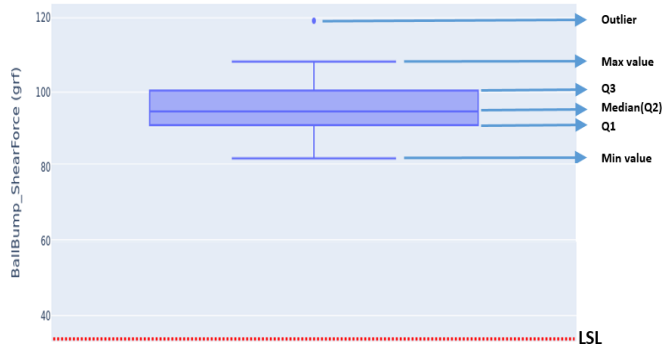


Figure 7. Boxplot of Ball Shear Test

The boxplot above shows the data from the Ball shear Chip to Lead test, with the lowest quartile (Q1) =91.14 and the highest quartile (Q3) =100 and median =94.86 and Cpk= 3,069. In the boxplot, there is 1 data outlier (higher) than the other data distribution, but the outlier is within the spec. The data distribution is not too wide, meaning that the data values do not have significant differences in value.

Table 24. Descriptive statistics of Bump Shear test

Statistics

Variable	Total Count	Mean	StDev	Minimum	Q1	Median	Q3	Maximum	Range
Bump Shear	40	132,71	9,52	105,99	126,83	132,19	139,36	154,00	48,01

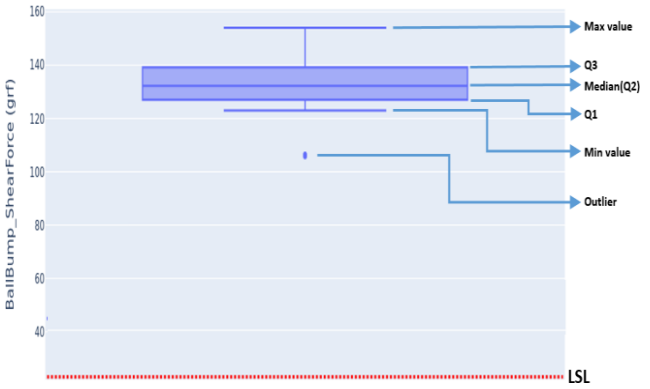


Figure 8. Boxplot of Bump Shear Test

The boxplot above is the result of the Bump Shear test, where the lowest quartile =126.83 and the highest quartile =139.36 with a median =132.19. The boxplot found one outlier with a value lower than the other values, but the value is still within the spec, the data distribution in this test does not have a significant difference in value and is within the specification limits.

In the destructive tests (ball and bump shear), values that were not in line with other values (outliers) were observed. The possibility of outliers was investigated using a fishbone diagram, the outlier variables were grouped into bonding machine and data collection method, as can be seen in figure 9. For the bonding machine, the parameters and mechanism of the machine were in accordance with the specifications. For the data collection method, the testing machine is calibrated and the parameters used are appropriate, it is concluded that outliers occur because the data collection method is still manual so that when the tester's position is not correct when testing the object, the resulting shear data has a data value that is too high or too low.

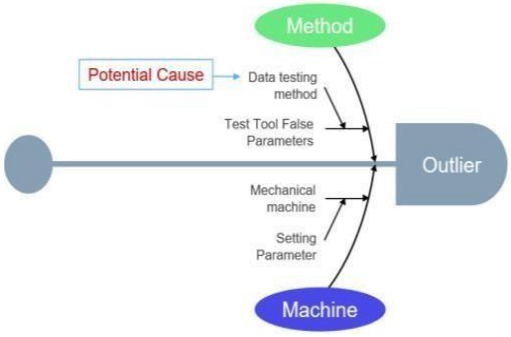


Figure 9. Fishbone Diagram of outlier bump shear result

3. Ball/Bump Dimension

Table 25. Descriptive statistics of Ball Dimension measurement

Statistics

Variable	Total Count	Mean	StDev	Minimum	Q1	Median	Q3	Maximum	Range
BALL (X)	30	73,677	1,154	71,900	72,750	73,650	74,525	76,100	4,200
BALL (Y)	30	76,820	1,490	74,200	75,750	77,050	77,825	79,500	5,300
BALL (Z)	30	27,717	1,166	26,100	26,775	27,500	28,625	30,300	4,200

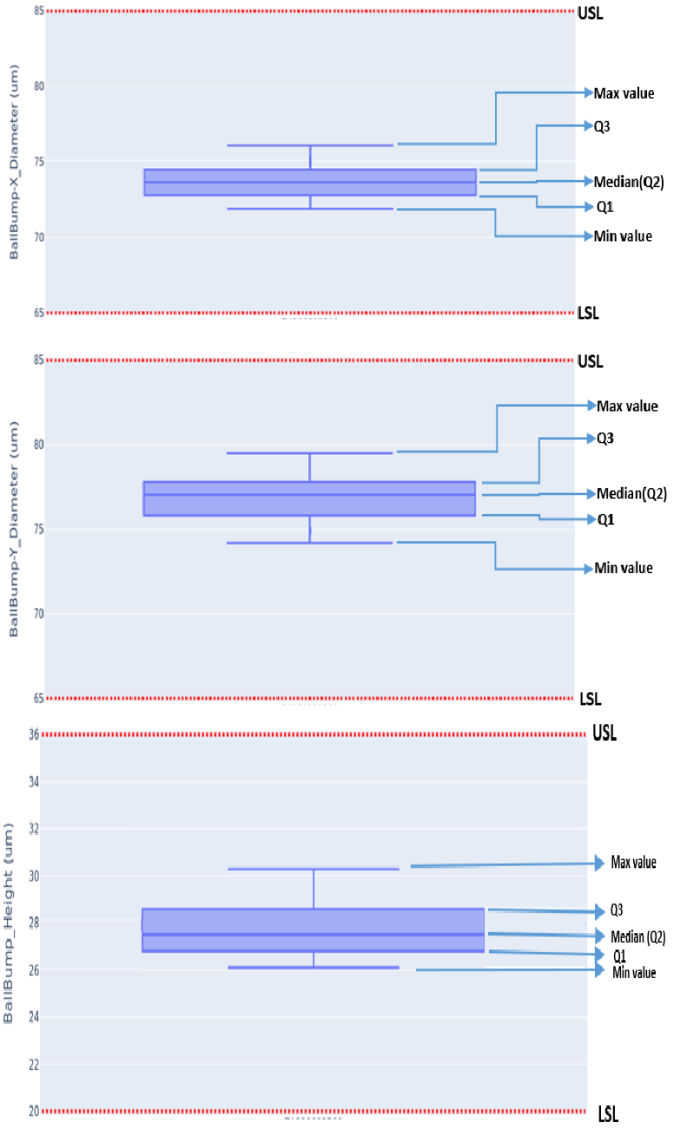


Figure 10. Boxplot of Ball Dimension measurement

The boxplot above is the result of measuring the ball dimensions (X,Y) with LSL = 65µm and USL = 85µm and ball height (Z) LSL = 20µm and USL = 36µm. It can be seen that the ball size (X, Y and Z variables) does not exceed the USL and LSL limits. The boxplot above shows a good distribution of ball dimension data, characterized by no significant difference in the value of the ball measurement results and the shape of the box that does not widen, meaning that the test data is normally distributed.

Table 26. Descriptive statistics of Security Bump (bottom) Dimension measurement

Statistics

Variable	Total Count	Mean	StDev	Minimum	Q1	Median	Q3	Maximum
SEC BUMP-BOTTOM (X)	30	90,040	1,576	87,500	88,600	89,600	91,600	92,600
SEC BUMP-BOTTOM (Y)	30	90,423	1,527	87,400	89,400	90,150	91,650	93,400

Variable	Range
SEC BUMP-BOTTOM (X)	5,100
SEC BUMP-BOTTOM (Y)	6,000

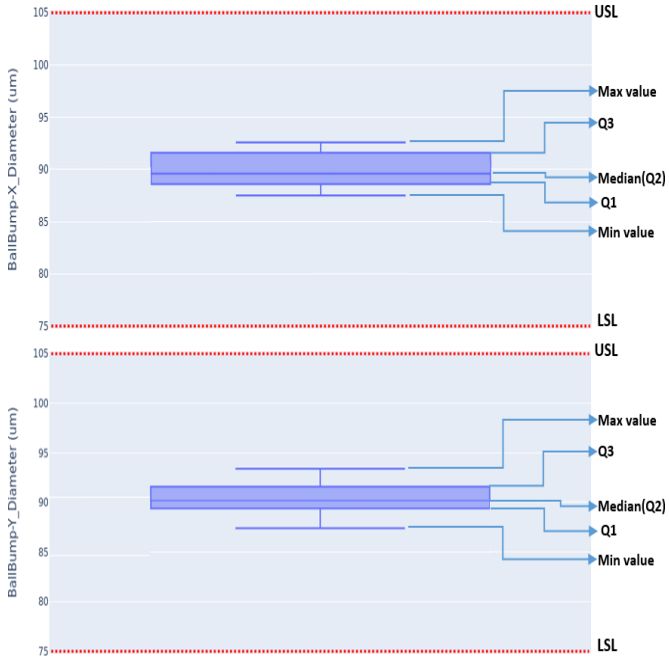


Figure 11. Boxplot of Security Bump (bottom) Dimension measurement

The boxplot above shows the measurement results of the Bottom bump dimension, LSL value = 75µm and USL value = 105µm. It can be seen that the distribution of the data is good, where the result data is between the specified spec limits and there is no significant difference in value from the results of the bump measurement data.

Table 28. Descriptive statistics of Loop Height

Statistics

Variable	Total Count	Mean	StDev	Variance	Minimum	Q1	Median	Q3
LOOP HEIGHT CTL	70	206,89	5,82	33,91	196,10	201,78	207,15	211,53
LOOP HEIGHT CTC	30	233,12	4,27	18,24	221,00	230,12	234,00	236,10

Variable	Maximum	Range
LOOP HEIGHT CTL	218,90	22,80
LOOP HEIGHT CTC	240,40	19,40

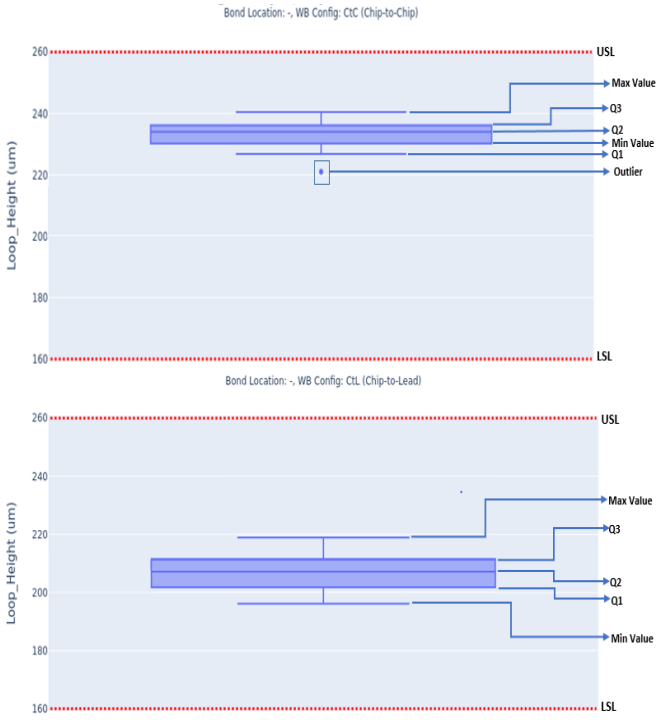


Figure 12. Boxplot of Loop Height

The boxplot above shows the Chip to Chip and Chip to Lead Loop Height measurement data with LSL = 160µm and USL = 260µm. It can be seen in the CTC Boxplot that there is 1 data value that is low and out of the line of other data distribution, but the loop height measurement data is within the spec limit range and normally distributed.

C. Clamper Management

a. Clamper List

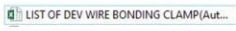
To record all the clamper-kits in the Development Department, both the new LDSO 8-1 clamper and the previous clamper-kits that have passed the mechanical buyoff test to make it easier to use the clamper-kit to be used, the researcher has recorded all the clamper-kits in the form of a list in Excel, the results are as in the table 29.

Table 29. Clamper list result

Box No	LF Size	Package	UTCSK C-Kit	Part Number	Labeling	Remark
1	LSS (Thin ISO)	LDSO-14-2	Lead Clamper	WP30627	PG-DSO-14-2 A7097-C002-015	Shinkawa 3 Set (New CP, jan 2022)
			Paddle Adaptor	HP30627	A7097-C002-015	
			Heat Spacer	AD67081	A7097-C002-015	
2	LSS (Thin ISO)	LDSO-14-2	Lead Clamper	WP30667	PG-LDSO-14-2 A7362-C001-008	Shinkawa 3 Set
			Paddle Adaptor	HP30667	PG-LDSO-14-2 A7362-C001-008	
			Heat Spacer	AD67081	PG-LDSO-14-2 A7362-C001-008	
3	LSS	LDSO 14-1 THIN ISO	Lead Clamper	WP30644	PG-DSO-14-1 A7464-C001	Shinkawa 3 Set **Old Design**
			Paddle Adaptor	HP30644	PG-DSO-14-1 A7464-C001	
			Heat Spacer	AD67081	PG-DSO-14-1 A7464-C001	
4	LSS	LDSO 8-1	Lead Clamper	WP30737	PG-LDSO-8-1 A7468-C005-001	Shinkawa 3 Set
			Paddle Adaptor	HP30737	PG-LDSO-8-1 A7468-C005-001	
			Heat Spacer	AD77014	PG-LDSO-8-1 A7468-C005-001	
...	...	...	...	...	...	...
			...	...	...	
			...	...	...	

All clamper-kits that are acceptable for use have been recorded by researchers, a total of 47 boxes of various types of packages have been recorded so far. Clampers in the Development department are recorded in the form of a list with labels and descriptions that will be used as a reference for users if they want to find and use Clamper-kit. The implementation can be described as table 30.

Table 30. Description of how to use

No.	Description	
1.	Users can open the clamper list file with the file name "LIST OF DEV WIRE BONDING CLAMP" that has been shared.	
2.	Then users can search for the required Clamper by searching in Package.	
3.	If you have found the package you are looking for, make sure to see the List Number / Box number to make it easier to pick up the clamper in the cabinet later.	

b. Clamper Storage Management

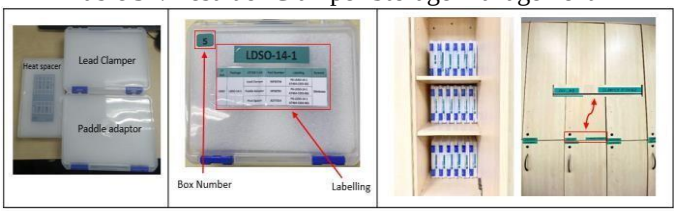
After recording all the Clamper-kits in the Development department, the researcher then carried out management for the storage of the clamper, the form of action that the researcher did was:

[1] Combining / summarizing in 1 box containing lead clamper, paddle, and heat spacer.

[2] Making numbering according to the list order and standard labeling.

[3] Organized the storage of all clamper boxes in a cabinet at the DEV office.

Table 31. Result of Clamper Storage Management

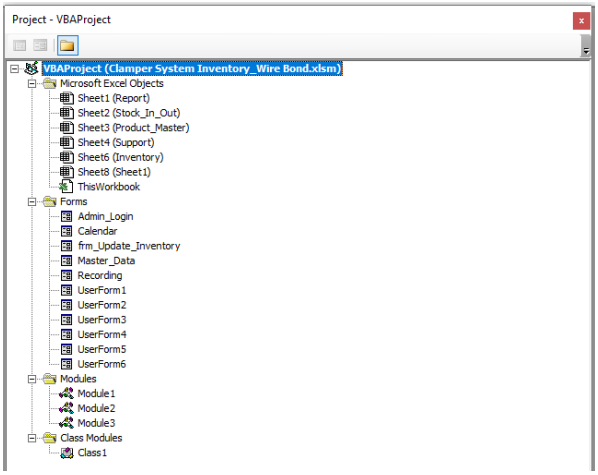


c. Clamper System Inventory

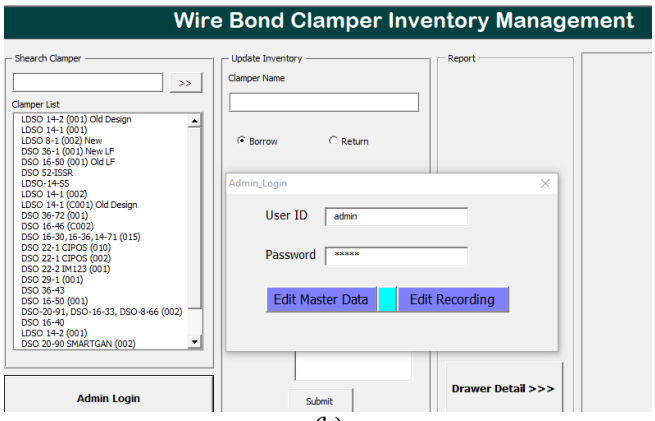
For the use of Clamper-kit an inventory management system is required, this simple inventory system is created using Excel Software in Visual Basic for Application with Plug In Developer. Where, users must fill in the page on this system when they want to borrow or return the Clamper-kit used.

1) Visual Basic Dasboard

The Worksheet consists of several required program system display forms, which consist of a calendar page, login page, recording, inventory update and master data.
Every form contains several commondbotton, textbox, listbox that contain commands or codes to display the system that has been created.



(a)

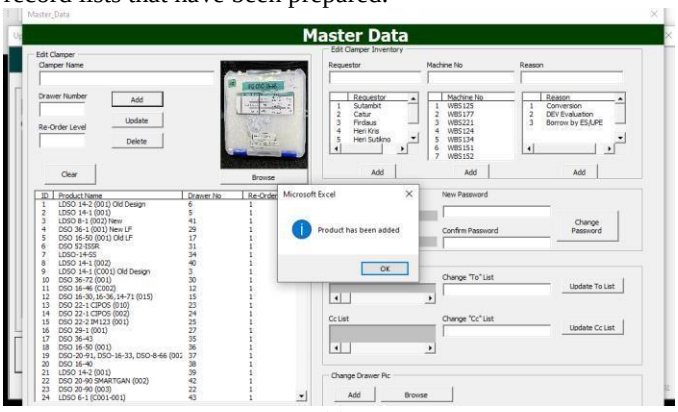


(b)

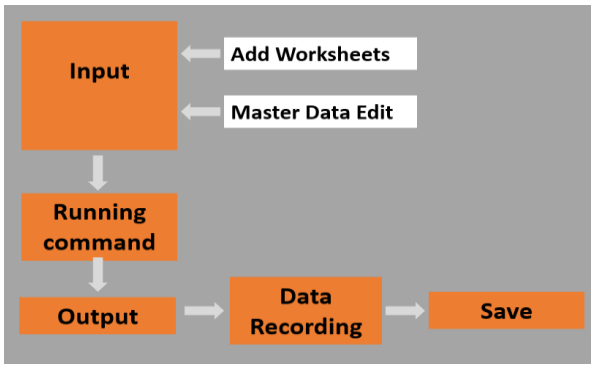
Figure 13. (a) Screenshot worksheet (b) Screenshot Dasboard of the system

2) Input Data List

After the dashboard and program can be run, it is necessary to input the previously registered Clamper list data manually in Edit Master Data. Click the "Admin login" button, a worksheet form will display to insert a password, then click "Edit Master Data", and edit the clamper by entering all the record lists that have been prepared.



(a)

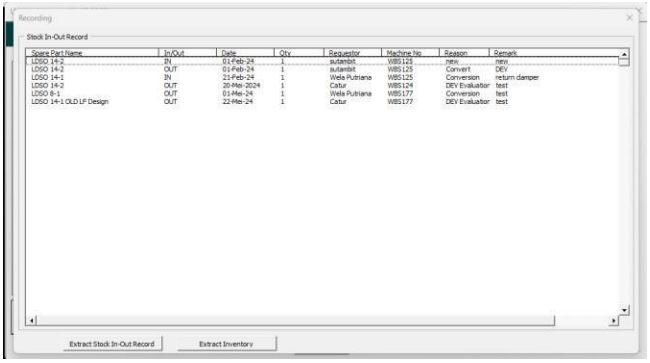


(b)

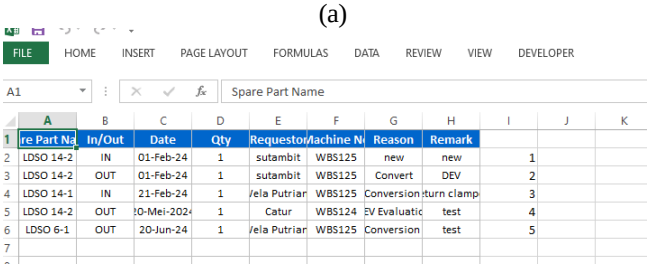
Figure 14. Schematic overview of Clampers inventory system program structure

3) Output view

The output of the system is a record of outgoing and incoming items, which is generated from every time the user submits. The output consists of records in the form of Excel that can be saved, to be able to see it, need to log in as Admin first.



(a)



	A	B	C	D	E	F	G	H	I
1	re Part Na	In/Out	Date	Qty	Requestor	Machine No	Reason	Remark	
2	LDSO 14-2	IN	01-Feb-24	1	sutambit	WBS125	new	new	1
3	LDSO 14-2	OUT	01-Feb-24	1	sutambit	WBS125	Convert	DEV	2
4	LDSO 14-1	IN	21-Feb-24	1	Vela Putriar	WBS125	Conversion	turn clamp	3
5	LDSO 14-2	OUT	20-Mei-2024	1	Catur	WBS124	EV Evaluatic	test	4
6	LDSO 6-1	OUT	20-Jun-24	1	Vela Putriar	WBS125	Conversion	test	5
7									

(b)

Figure 15. (a) Output recording view of the system and (b) Output view when saved

IV. Conclusion and Suggestions

A. *Conclusions*

Based on the results of the research that has been carried out in this study, it can be concluded that the objectives in this aspect of the research have been achieved through various stages and tests.

1. Test and analyze the new clamper to ensure that it is acceptable for the needs or package to be used.
   The new Clamper-KIT package LDSO 8-1 can be used after various stages of mechanical and bonding quality analysis, no Clamper-related problems were found.
2. Recorded all clampers and organized their storage and created a simple inventory system to facilitate the organization of clamper-kits in the Development department.

B. *Suggestions*

This research contains 2 points, first testing and analyzing the new Clamper package, it is necessary to ensure that the test is carried out following the procedure to ensure that no Clamper-related errors occur.

Second about Clamper management, this study has recorded all the Clampers in the Development Department, it is hoped that the new Clamper can later be recorded and entered into the list that has been made and for the use of Clamper-kit is asked for discipline to fill in the inventory system that has been made and for storage after use can be placed in a cabinet that has been determined.

V. Bibliography

[1] J. L. [1]. X. Y. [1]. R. H. [1]. K. Y. [1]. M. L. [1]. H. Z. [1]. J. X. [1]. N. C. [1]. H. W. [1]. a. B. Q. [4]. [2] Daohua Zhan [1,2], "ALightweight Method for Detecting IC Wire Bonding Defects in X-ray Images," *Micromachines*, vol. 1119, p. 14, 2023.

[2] P. S. [3] Chauhan, A. Choubey, Z. Zhong and M. G. (. Pecht, "Copper Wire Bonding," 2013.

[3] "Semiconductor BackendTools Catalog," 01 December 2023. [Online]. Available: https://oricus-semicon.com/wp-content/uploads/2022/03/ORICUS_Catalogue_WB_BB_WCI.pdf..

[4] T.-C. Chang and K.-S. Chen, "Testing process quality of wire bonding with multiple gold wires from viewpoint of producers," *Internasional Journal of Production Research*, pp. 1-14, 2018.

[5] C. Wang, "The Quality Test of Wire Bonding," *School of Mechanical & Electronic Engineering Tianjin Polytechnic University Tianjian*, December, 2009.

[6] "Wire Bond / Ball Shear Application Note," 06 December 2023. [Online]. Available: Wirebonding Application Notes | PDF | Building Engineering | Materials (scribd.com).

[7] Z. Zhong, "Overview of wire bonding using copper wire or insulated wire," vol. 51(1), p. 4–12, 2011.

[8] Junaidi, "Deskripsi Data Melalui Box-Plot," Juni, 2015.

[9] P. [13] David F. Williamson, D. Robert A. Parker and M. and Juliette S. Kendrick, "The Box Plot: A Simple Visual Method to Interpret Data," *Annals of Internal Medicine* , 1 June 1989.

[10] A. A. R. A. S. Fadia Karlika Sari1, "INVENTORY SYSTEM DI SYAHIDA SKINCARE," *Jurnal Dialektika Informatika (Detika)*, vol. 3, pp. 48-53, Mei, 2023.

ATTACHMENT

Table 32. Data Colle

	Ball/Stitch Pull						Ball/Bump Shear							Loop Height						Security Bond (Bottom Bump)			
	Chip-Lead			Chip-Lead			Ball (CTL)			Bump Downbond				Chip-Chip			Chip-Lead			Spec 75-105um		
	Ball Pull			Stitch Pull			Ball Shear			Bump Shear				Spec 130-290um			Spec 130-290um				Size (X)	Size (Y)
	Spec >4g			Spec >4g			Spec >33.7g			Spec >23.1g													
		Reading	Mode		Reading	Mode		Reading	Mode		Reading	Mode								Unit 1	1	90,3	87,4
Unit 1	1	17,758	1	1	13,903	2	Unit 1	1	99,12	2	Unit 1	1	130,56	2	Unit 1	1	234	Unit 1	1	209		2	89,4	89,7
	2	18,933	1	2	13,435	2		2	107,86	2		2	106,3	2		2	233		2	215		3	88,6	90,4
	3	17,941	1	3	13,606	2		3	98,17	2		3	126,57	2		3	238		3	214		1	88,6	88,6
	4	16,066	1	4	11,721	2	Unit 2	1	94,74	2	Unit 2	1	105,99	2	Unit 2	1	237		4	201	Unit 2	2	90,6	92,5
	5	19,543	1	5	13,368	2		2	103,23	2		2	134,14	2		2	228		5	207		3	90,6	89,7
	6	18,968	1	6	11,387	2		3	108,2	2		3	126,64	2		3	228		6	203		1	91,6	90,2
Unit 2	1	19,232	1	1	11,52	2	Unit 3	1	104,73	2	Unit 3	1	131,2	2	Unit 3	1	232		1	211	Unit 3	2	87,5	91,6
	2	17,856	1	2	12,581	2		2	97,4	2		2	128,72	2		2	234		2	214		3	87,6	91
	3	18,127	1	3	12,503	2		3	93,35	2		3	142,24	2		3	228		3	211		1	92,5	90,1
	4	16,882	1	4	13,726	2	Unit 4	1	96,08	2	Unit 4	1	125,75	2	Unit 4	1	232	Unit 2	4	204	Unit 4	2	90,5	92,1
	5	18,395	1	5	12,865	2		2	101,66	2		2	127,52	2		2	227		5	202		3	89,6	90,7
	6	19,346	1	6	12,267	2		3	92,43	2		3	132,03	2		3	230		6	210		1	89,1	91,5
Unit 3	1	18,724	1	1	12,292	2	Unit 5	1	92,1	2	Unit 5	1	132,72	2	Unit 5	1	229		1	215	Unit 5	2	87,9	91,2
	2	19,16	1	2	13,416	2		2	95,58	2		2	132,34	2		2	221		2	212		3	88,4	91,8
	3	17,857	1	3	13,01	2		3	94,51	2		3	131,35	2		3	234		3	219		1	92,6	89,4
	4	16,98	1	4	12,147	2	Unit 6	1	101,49	2	Unit 6	1	133,89	2	Unit 6	1	234	Unit 3	4	208	Unit 6	2	90,6	89,6
	5	17,613	1	5	12,407	2		2	93,45	2		2	138,83	2		2	231		5	200		3	88,6	90,1
	6	18,801	1	6	13,635	2		3	86,65	2		3	134,5	2		3	236		6	198		1	89,3	89,1
Unit 4	1	17,189	1	1	12,708	2	Unit 7	1	94,71	2	Unit 7	1	139,62	2	Unit 7	1	233		1	210	Unit 7	2	91,6	88,5
	2	18,713	1	2	13,025	2		2	87,14	2		2	134,82	2		2	235		2	215		3	92,6	93,4
	3	17,987	1	3	13,545	2		3	91,74	2		3	126,21	2		3	235		3	212		1	91,6	89,5
	4	16,63	1	4	11,75	2	Unit 8	1	95,29	2	Unit 8	1	133,41	2	Unit 8	1	234	Unit 4	4	202	Unit 8	2	91,6	91,5
	5	17,556	1	5	12,529	2		2	89,49	2		2	127,38	2		2	230		5	201		3	92,6	92,6
	6	16,77	1	6	13,992	2		3	87,39	2		3	137,43	2		3	233		6	202		1	88,6	88,4
Unit 5	1	18,51	1	1	13,814	2	Unit 9	1	98,82	2	Unit 9	1	145,53	2	Unit 9	1	240		1	207	Unit 9	2	89,5	89,4
	2	19,624	1	2	14,237	2		2	96,78	2		2	131,89	2		2	236		2	212		3	88,6	89,4
	3	17,58	1	3	15,31	2		3	92,75	2		3	146,36	2		3	238		3	216		1	89,6	88,4
	4	17,22	1	4	13,624	2	Unit 10	1	87,62	2	Unit 10	1	148,48	2	Unit 10	1	239	Unit 5	4	204	Unit 10	2	91,6	92,4
	5	18,243	1	5	13,483	2		2	89,63	2		2	154	2		2	236		5	199		3	89,4	92,5
	6	18,658	1	6	12,381	2		3	95,86	2		3	125,23	2		3	240		6	198				