



Understanding Jig Alignment Error Occurrences for Substrate 1-Map Strips

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Singulation is a process in a semiconductor industry where high dense strips were singulated into single units. Jig saw singulation was the updated technology where strips were seated and vacuumed on a rubber nest jig during singulation. Jig saw singulation is also practical for high volume manufacturing as it demands minimal indirect materials. To cut the strips, jig alignment with the strip was measured by the machine to ensure that the rubber nest jig will not be cut and damaged while the strip is being singulated. However, with the different upstream process that the strip undergone, machine prompt frequent jig alignment errors when the machine detected that the strip saw street has high displacement with the recorded alignment of the saw street of rubber nest jig. Through this study, the authors have driven to understand the jig alignment errors occurrences as well as the assistance that can be made for the strip to be processed. The authors also included the study of the risks that might be imposed on both rubber nest jig and the affected strips, as well as the recommendations when jig alignment errors were encountered.

Keywords: 1-map strip; jig alignment error; jig saw singulation; singulation process.

1. INTRODUCTION

Jig saw singulation is a type of singulation process where the substrate strips were being sawn into individual units while the strip was nested on a rubber jig. Strips were seated and vacuumed on the rubber jig prior it proceeds with jig saw. Shown in Fig. 1 is a sample of a rubber nest jig, while Fig. 2 shows how the strips were vacuumed in place.

Jig sawing is practical in for high volume production as indirect materials to saw units were minimal. However, jig saw singulation requires different design or rubber jig as it should match with the strip configuration of the strip to be sawn.

For the strips to proceed with singulation, alignment should satisfy the limit settings at the machine. Alignment of the rubber jig to the substrate strip, alignment of indexing to the unit pitch, and alignment of the blade to the sawing street, which are all performed and measured by the machine. Once alignment was not satisfied, machine will prompt errors for assistance [1-5]

One of the errors that was frequently encountered was the jig alignment error. Jig alignment errors were one of the hindrances of the strips to be singulated at jig saw singulation. Frequently, strips that have encountered jig alignment errors were pulled out at the machine and transferred with tape saw singulation where strips will be mounted with tape prior singulation.

Authors have come up with the idea to study and understand the cause of occurrences of jig alignment errors and to come up with the recommendations that would lessen the occurrences.

2. METHODOLOGY

The authors have taken to study the process of jig saw singulation and the importance of jig alignment. Next to be validated was how jig alignment error occurs. Assistance to the problem was also considered to be found with the study. Risks of strip acceptance through adjustments were also included on the validation. Lastly, the authors recommend the alternatives that can be considered with the encountered issues considering the results and validations that was brought about by the methodology.

2.1 Understanding Jig Saw Singulation and Importance of Jig Alignment

Package singulation is a process in the semiconductor industry where units build in one strip will be separated into individual units. To produce good units, alignment is the highly considered factor for singulation. Misalignment cutting might cut and damage the components inside the unit, or cause misalignment at unit sockets during board mounting. Jig saw singulation was used for high dense strips as this requires minimal resources.

However, jig saw singulation demands higher accuracy for alignment. Rubber nests were used as jigs where strips to be singulated was vacuumed in. To proceed with singulating the strip, jig alignment with the strip should be acceptable. Jig alignment teaching is an alignment procedure where the jig groove that serves as an alignment guide of the jig to the rubber nest was taught on the machine. Measurement of the jig alignment will be related with the alignment of strip to be cut.

In jig saw singulation, the blade saw through with the strips in between the rubber nest where the strip was rested into. Jig alignment with the strip helps to avoid cutting the rubber which holds the units. Rubber that was damaged overtime might cause vacuum errors that would result to unit movements leading to misaligned cut. As illustrated in Fig. 3, blade saw through the units between the rubber nest pockets [6-11].

With the current set-up, it has been found out that jig alignment serves as an important setting that would avoid the damage of rubber nest jig. Jig alignment relates the alignment of the rubber jig to the actual strip to be processed.

2.2 How Jig Alignment Error Occurs and How Can it be Assisted

Jig alignment errors were frequently encountered with high dense strips that was evident high strip expansions. Jig alignment errors occurs when the machine detected that the strip saw street has high displacement with the recorded alignment of the saw street of rubber nest jig. Accumulation of strip expansions prompts the machine jig alignment error to alert the operator that strip alignment was already beyond on what the jig alignment can cater. Assistance can be done by manual loading the strip at the rubber

nest jig to compensate the alignment. However, this practice was risky as it compromises the alignment of the strip with the rubber nest jig. Shown in Fig. 4 are the illustrations of alignment of units to the rubber nest jig that would not cause jig alignment error, which is the left illustration, and on the right is the alignment of units to the rubber nest jig that would cause jig alignment error.

misaligned and is not acceptable with the jig alignment limits setting versus the strip actual position. Strip picker placement height can be adjusted in this scenario to result on corrected alignment of strip at the chuck table. Tight placement of the strip at the chuck table causes the strip to move upon strip picker up position, while loose placement moves the strip upon free fall at chuck table.

Jig alignment errors can also be encountered with the strips that has no expansion and warpage issues. When strip was validated with no issues, but error occurs, the strip placement with the rubber nest jig was found to be

Though jig alignment issues can be addressed and assisted, there are setbacks and risks on both the strips and the rubber nest jig once the jig alignment was loosened for the strips to be accepted.



Fig. 1. Rubber nest jig sample

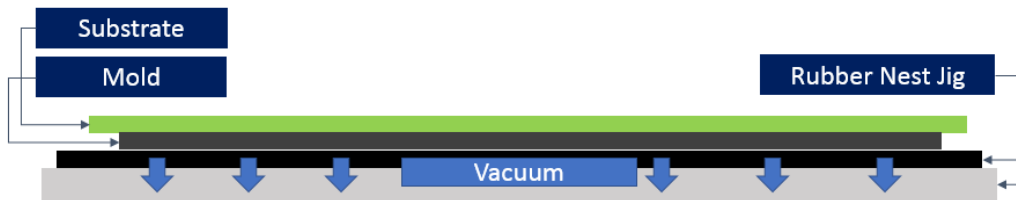


Fig. 2. Strip seated with rubber nest jig

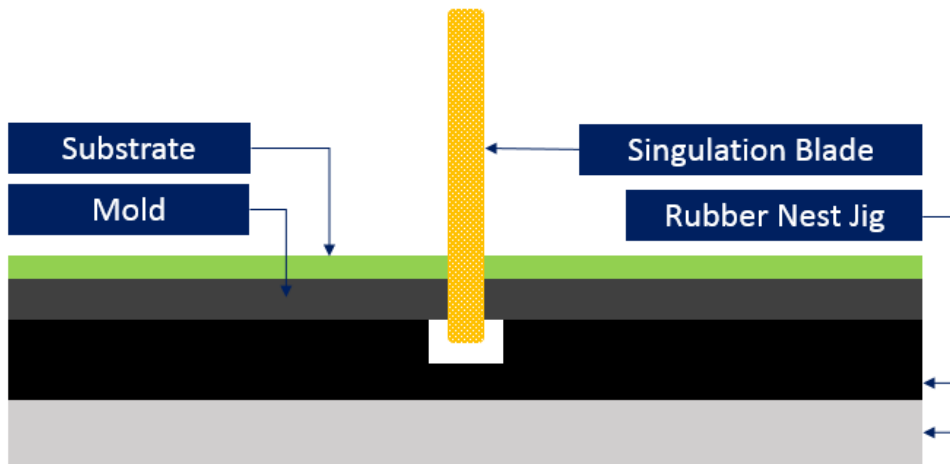


Fig. 3. Rubber nest assembly with blade saw through

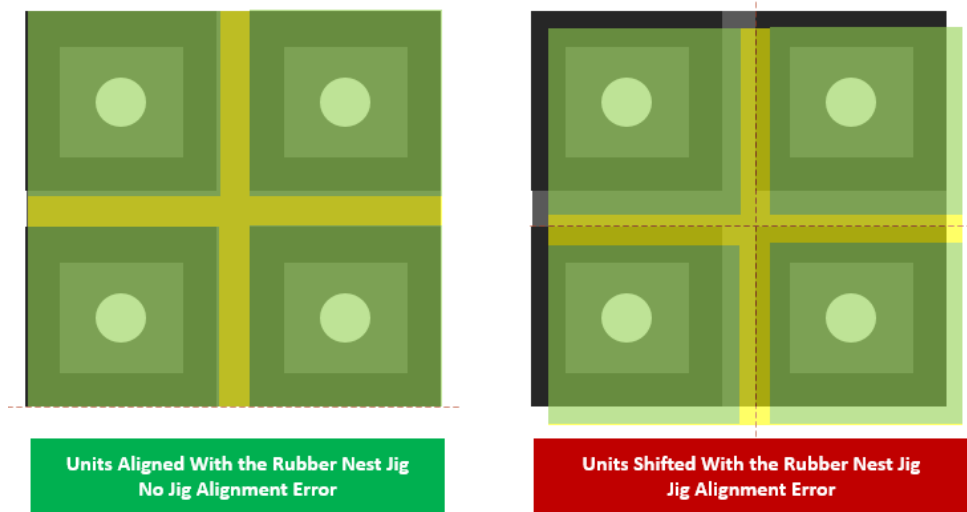


Fig. 4. Unit alignment with the rubber jig nest

2.3 Risks of Strip Acceptance with Jig Alignment Issues

Jig alignment was used to ensure that the strips were aligned with the chuck table rubber nest jig. Jig alignment errors occur when the machine measured that the strip alignment and placements with the rubber nest jig was high enough to be compensated. During validation, 100-micron (μm) difference can be catered and allowed by the machine. Beyond 100-micron expansion prompts jig alignment errors. 100-micron was set on the machine as guard band to both strip and rubber nest jig. Given with tight clearances and complexities of a unit, high expansion is risky with the strips and machine prompts error for assistance. Rubber nest jig is at risk as well for cut walling that would eventually lead to fail on holding the units in place.

However, strips should be processed to avoid yield losses. Some strips that cannot be catered with manual strip alignment and consistently errors with jig alignment was processed with tape sawing. These strips should undergo close monitoring as it was already prone with misaligned cut. High expansions of the strip result also with misaligned unit pitching which should be assisted during singulation.

Strips with high expansion that were accepted at jig saw singulation should also be monitored. Though the strips can be successfully singulated, rubber nest jig might suffer. Fig. 5 gives a comparison of rubber nest pockets, one on the left with good rubber nest walling condition, while

pocket on the right has rubber nest wall thinning due to blade cut upon singulation.

Following the actual strip alignment considering the expansion results for the blade to cut through with the rubber. Several cuts induce thinning of the rubber nest walling which later results to unit movement as it fails to hold the unit in place during singulation. Rubber nest wall thinning reduces the area that holds the unit. When strip movements occur, misalignment of cutting the units can be encountered. Work piece vacuum errors might also be induced specially with smaller units resulting the strip to be washed out.

3. RESULTS AND DISCUSSION

With the data collected through the methodology of the study, it has been found out that jig alignment was important for jig saw singulation as it was used to ensure the alignment of the strip with the rubber nest jig. It was also used to calculate the displacement between the saw streets of rubber nest jig and the actual strip. Jig alignment serves as a guide to protect the rubber nest jig from cutting by the blade during singulation while ensuring that the units produced is with high quality.

High expansions of the strip that cannot be catered by jig alignment prompt jig alignment errors. Proceeding the affected strip imposes risks on rubber nest jig and on the units as well. Tape saw singulation can be used for the strips that cannot be accepted by jig saw, provided that the strip will be closely monitored for possible occurrence of misaligned cuts.



Fig. 5. Comparison of rubber nest pockets

Strip with high expansions that was still catered at jig saw singulation gives of the risk of cutting the rubber nest jig. Thinning of rubber nest walling can result to unit movement during singulation and worse can result to work piece vacuum error which can wash out the units.

4. CONCLUSION AND RECOMMENDATIONS

Through the results gathered in this study, the authors would like to conclude that substrate jig alignment errors should be properly understood in to provide the appropriate actions that the error demands. Jig alignment is vital for both rubber nest jig and actual strips when processed with jig saw singulation.

The authors would like to recommend that the strips affected by high expansion should be catered with tape saw singulation with close monitoring on the cutting response. This activity would help on avoiding the rubber nest tool to be damaged and at the same time assisting the cutting quality of the units. In luxury that the strip design can be changed to avoid expansion, it was highly recommended to be considered on the next technologies.

Studies for improvement and innovation of the future devices might consider the elimination of substrate expansions. Further development and usage of different materials with suitable coefficient of thermal expansions can be

considered as devices undergo series of heat process steps during its assembly. On the other hand, it is a recommendation to explore new singulation machine technologies that are also evolving to be ready in solving issues related to strip conditions. Future study is suggested on the developments to be discovered and explored as semiconductor world is continuously growing.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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