



# Maximizing the Process Capability of Singulation Machine by Dual Work Piece Cutting on Circular Tape Frame

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## Authors' contributions

*This work was carried out in collaboration amongst the authors. All authors read, reviewed, and approved the final manuscript.*

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## ABSTRACT

Tape saw singulation is the process where a strip was mounted on the tape attached on the frame and then sawn into single units. Circular tape saw singulation only caters one panel of the two-paneled strip which was found to be consuming with the machine capacity and resources. Driven by continuously growing volumes of customer demands at the Philippines for the past two years, it was a challenge for the machine to maximize its capacity while minimizing the cost and resources. Opportunity was found on exploring the idea of dual work piece where two strip panels were catered by one circular tape frame. Dual work piece application would not only maximize the machine capability and capacity but also reduce the cost of resources consumed per strip loading. In this study, the authors have explored the workability of dual work piece cutting where two panels can be catered on one circular frame instead of the current one panel per circular frame. Dual Work Piece application was found to be effective to achieve the goal of maximizing the machine capacity while trimming down the expenses by 50% that was brought about by the resources demanded to process the strips at singulation. With the results of the study, it was recommended for the dual work piece cutting be applied and explored on growing semiconductor industry.

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## 1. INTRODUCTION

Tape saw is a singulation process used to cater more complex devices where the strip was mounted in the tape and then sawn to produce individual units. Tape saw singulation uses frames to mount the tape, then inside the frame was the strip to be singulated. Tape saw singulation is shown in Fig. 1.

Frame with 8-inch diameter was used on the production line for singulation of two-paneled quad-flat no-leads (QFN) package strip. However, the frame can only cater one out of two panels per loading, thus one strip needs two frames and loaded separately on the singulation machine. The resources needed such as tape and frame were twice on the consumption per strip. Fig. 2 illustrates the two-paneled strips and its equivalent setup loading on the singulation machine.

With high customer demand for volumes, it was a challenge to maximize the machine capacity while reducing the cost of consumption for the resources. Circumstances at hand have engaged the authors to search for the opportunity to maximize the machine capability that can

improve the machine capacity at limited resources consumption.

## 2. METHODOLOGY

The challenges have pushed the authors to study the possibility of singulation of two panels mounted on one circular frame. First, the authors have simulated if the two panels can fit in one frame. Next was to verify if the machine can be programmed to singulate multiple strips per single frame loading. Results of the study to maximize the machine capability was the last to be done.

### 2.1 Exploring the Possibility to Mount Two Panels on One Circular Frame

The authors first explored if mounting of two panels on one circular frame is possible. It has been found out that two panels can fit inside the diameter of the circular frame, thus both panels can be mounted together as shown in Fig. 3. With the success of mounting both panels of the strip into one circular frame, the authors proceed to verify if the frame setup can be catered at singulation.

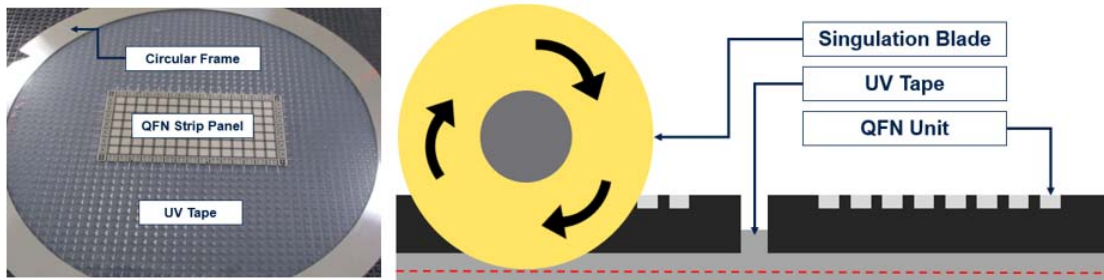


Fig. 1. Tape saw singulation process

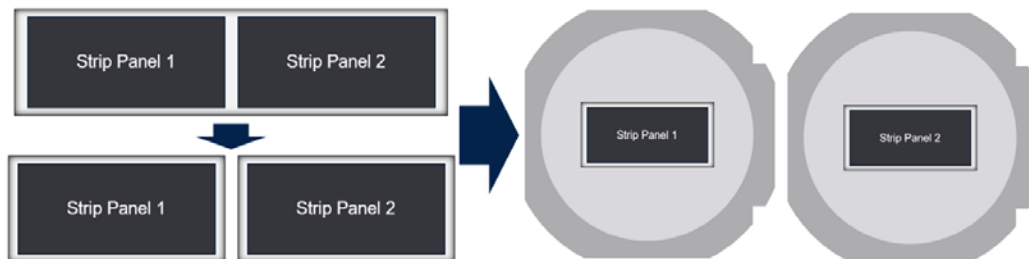
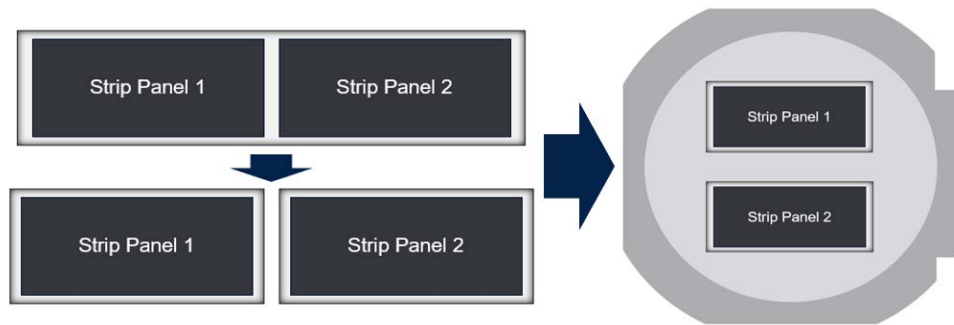


Fig. 2. One panel of the strip was mounted per circular frame



**Fig. 3. Two panels were both mounted on a circular frame**

### 2.2 Singulation Machine Capability for Multiple Strip Cutting

Tape singulation machine was verified capable to cater multiple strips per single frame loading. Dual work piece singulation program was applied where two panels of the strips which are called as work pieces will be cut on one circular frame. However, it was critical to consider the measurement on the distance between the two work pieces for the blade cutting travel. Entrance and exit travels of the blade may damage the adjacent strip if the separation in between was tight. Strip panels were assigned as different work pieces and will be cut separately.

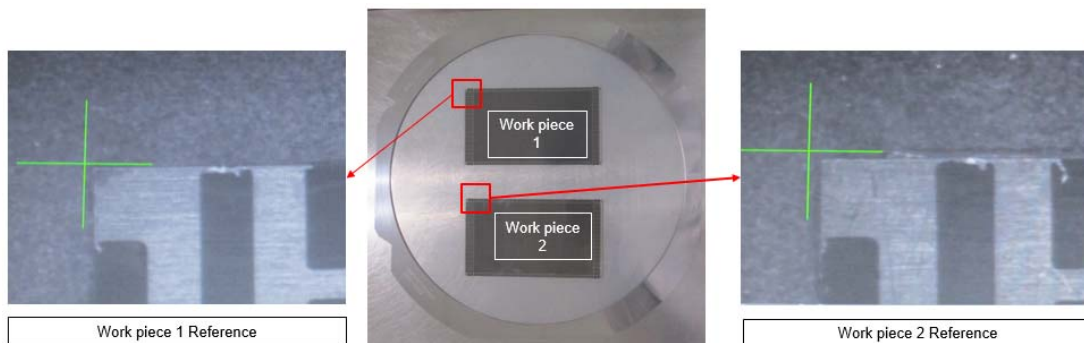
The illustration of dual work piece singulation is shared in Fig. 4, wherein work piece 1 is the strip panel mounted on the left and work piece 2 is the strip panel mounted on the right side of the tape. Chamfer of the frame serves as the reference as well as the loading orientation. Upon singulation, the machine will search for the reference points of the first work piece and perform the strip alignment prior cutting. The sequence will be

repeated on second work piece upon completing the cutting of the first strip.

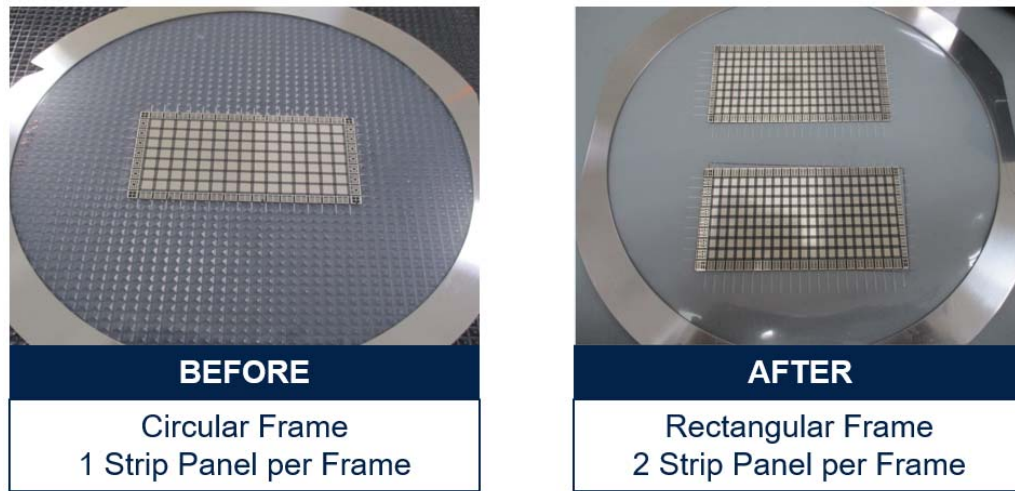
Dual work piece singulation have given the opportunity to maximize the machine capability. Application of the dual work piece singulation program can help to reduce the consumption of tape and frame by 50% per strip processed. Loading and unloading of the frame was reduced by half and can be used instead as free capacity.

### 3. RESULTS AND DISCUSSION

Mounting of two panels per one circular frame were verified to be doable and machine was found to be capable of dual work piece singulation. Maximizing the machine capability through application of dual work piece singulation was found to be an opportunity to maximize the machine capacity and reduce the consumption of resources. Works and studies discussed in [1-6] focusing on the cutting method, design, and process improvement were helpful in this study. The actual strip singulated with the application of dual work piece program compared with the previous setup with only one panel mounted on the circular frame is shown in Fig. 5.



**Fig. 4. Dual workpiece singulation reference points**



**Fig. 5. Before and after application of dual work piece singulation program**

With the conducted study and the collected results, the authors have found out that the application of dual work piece singulation program can help on the objective to maximize the machine capacity while saving resources.

#### **4. CONCLUSION AND RECOMMENDATIONS**

Through the results of the conducted study, the authors have concluded that one strip of QFN device with 2 panels can be catered on one circular tape frame. Singulation machine have also maximized its capability to cater multiple strips per single frame loading.

The authors also concluded that the use of dual work piece singulation program is essential on maximizing the machine capacity while saving resources. Application of the program have improved the indirect material consumption by half, and time consumed from frame loading and unloading was also minimized which can be used as free capacity of the machine.

It is recommended to consider the application of dual work piece singulation program for other package types as this was validated to be beneficial in terms of saving cost and maximizing the machine capability. Additionally, references shared in [7-10] would be of big help in realizing ideas for robustness and optimization in the assembly manufacturing.

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#### **COMPETING INTERESTS**

Authors have declared that no competing interests exist.

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