



# Different Vacuum Pad Design Effects with Z-Picker Assembly

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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

After singulation process where the strips are being cut into single units, unit tray loading comes next. Unit tray loading is the process where the singulated units will be picked up from the table and then place it in a tray pocket. Z-picker assembly executes the pick and placing activity through vacuum suction. Vacuum pads were installed on the Z-picker's vacuum pad holder area, and it contacts with the unit. Vacuum pads come with different design depending on dimension and configuration of the device in process. Pick and place process is prone for unit dislodge as it transfers the unit from one place to another. These unit dislodges will result to missing units and will be accounted for yield loss. In this study, the authors were driven to understand the Z-picker mechanism together with the effect of vacuum pad designs, aiming to find the best match that would lessen the occurrence of unit dislodges.

**Keywords:** Pick and place; tray loading; unit dislodge; vacuum pads; Z-picker.

## 1. INTRODUCTION

Unit pick and place or commonly called as unit tray loading is one of the singulation sub-

processes where the singulated units will be transferred individually from the singulation table to the tray pockets. Vacuum pad pickers were used to pick the units and place it with the tray

pockets through vacuum suction. Vacuum pad pickers were placed on the vacuum pad holder that can be found on the tip of the Z-picker assembly of singulation handler machines where vacuum line was installed.

Though the process is simple to pick the units and place it with the tray pockets, several units fell off from the vacuum pad pickers during unit transfer. Parameters of placing height and position have been verified without issues, and alignment of the pickers to the tray pockets were verified to be good as well.

Units that fell off during traveling were resulted to missing units which were yielded off from the lot quantity. Even if units were to be found on the singulation area, it was not recommended for picking up due to possible lot mixing. Problems at hand have pushed through the authors to dig deep and study further the assembly and mechanism of Z-pickers together with the vacuum pad designs.

## 2. METHODOLOGY

The authors have been encouraged to understand first the Z-picker assembly. Next, the authors have explored the vacuum pad designs. Through data collection, the authors aim to relate the study of mechanism on the possible solution of the fallen units observed at Singulation. Discussion of the data will be used for the

conclusion and recommendations on the applied best solution.

### 2.1 Z-picker Assembly

Singulation machine comes up with both sawing and pick and placing processes. For unit pick and place, Z-picker assembly was responsible. Z-pickers can be attached with vacuum pads of different designs and different configurations depending on the unit size being processed. Shown in Fig. 1 is the Z-picker assembly with installed vacuum pad.

Z-picker assembly is where the vacuum line suited for picking up the units was installed on. Five holes on the tip of the vacuum pad holder is where the air for vacuum suction takes place. In the middle hole, ejector pin was found to help push the units at the tray pocket upon placing. Ejector pins helps the unit to be detached from the vacuum pads. Shown on Fig. 2 is the illustration and actual sample of a Z-picker assembly.

High technology machines have at least 16 Z-pickers installed on the machine assembly. Singulated units will be individually picked one at a time, and then placed one at a time as well on the tray. The number of Z-pickers have corresponding set of vacuum pads which will be installed at the tip of Z-pickers to contact with the unit upon pick and placing.



Fig. 1. Z-picker with installed vacuum pads

## 2.2 Vacuum Pad Design

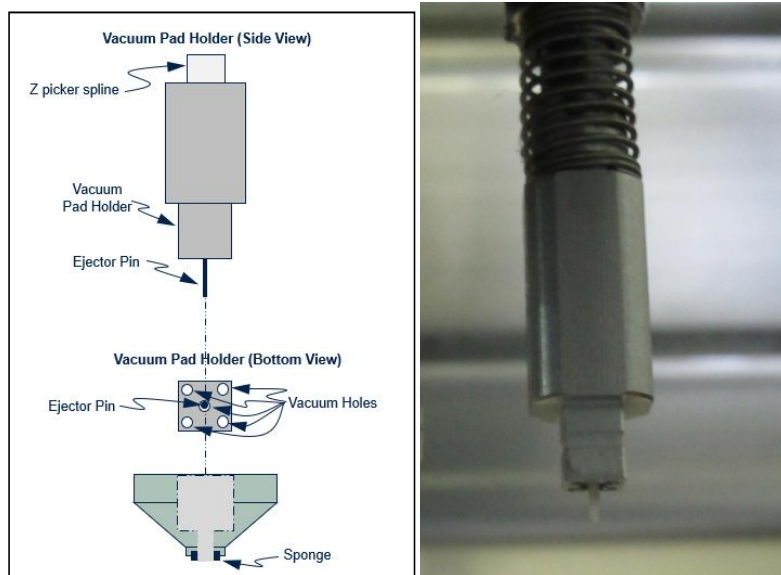
Vacuum pads were made from rubber which was placed on the tip of the Z-pickers. These vacuum pads have designs that varies depending on the unit dimension and configuration. Changing of vacuum pads were also part of a machine conversion from one device to another. Fig. 3 is a sample of vacuum pad.

Even with various designs and sizes, vacuum pad bases are the same to fit with the Z-picker. Vacuum pads have holes connected with the Z-picker holes for suction of units. Vacuum pads were designed to be an inverted pyramid to avoid hitting with other units. Also, target area for unit pick up is in the center which gives of the balance during pick and place. Inside the vacuum pads, two different designs of its walls

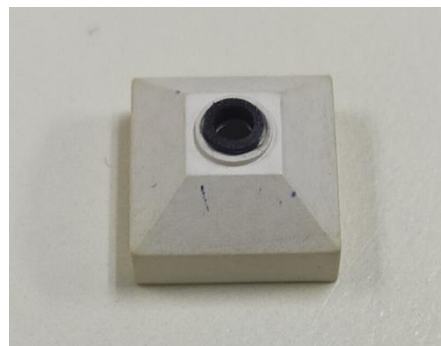
were found. One is the vacuum pads with flat design and the other has tapered design.

Vacuum pad walls with flat design were fully attached on the tip of the Z-picker assembly. This design has solid and rigid walling which gives off longer tool life and not easily wear off. On the other hand, vacuum pad with tapered design have inclined vacuum pad walls going to the vacuum hole. This design was less rigid but proven to be more effective than the flat type design. Both designs have hole at the center for vacuum suction.

The effects of different vacuum pad designs were further discussed upon installation of vacuum pads with the Z-picker. Validation and results were being analyzed with respect to the occurrence of unit dislodge.



**Fig. 2. Z-picker Assembly**



**Fig. 3. Vacuum pad sample**

### 3. RESULTS AND DISCUSSION

#### 3.1 Z-picker Assembly with Flat Vacuum Pads

Z-pickers with attached flat design of vacuum pads has more occurrence of unit dislodging during unit transfer from the table to the tray pocket. Upon installation of the vacuum pad with flat design, it has been found out that four holes for vacuum suction were covered with the vacuum pad walls. Fig. 4 illustrates the Z-picker attached with flat design of vacuum pad.

Suction was coming from the middle hole which the ejector pin can be found as well. High and

acceptable vacuum reading was displayed on the machine, but the actual unit suction was minimal. Thus, imposes high risk of unit dislodge.

#### 3.2 Z-picker Assembly with Tapered Vacuum Pads

Installation of vacuum pad with tapered design to the Z-picker assembly was found to be effective with minimal to zero occurrence of unit dislodge. Though walling of the vacuum pad is not as rigid as the flat design, tool life and its performance was still efficient. Units were vacuumed and placed on the tray without tilting as well. Z-picker installed with tapered design of vacuum pad is depicted in Fig. 5.

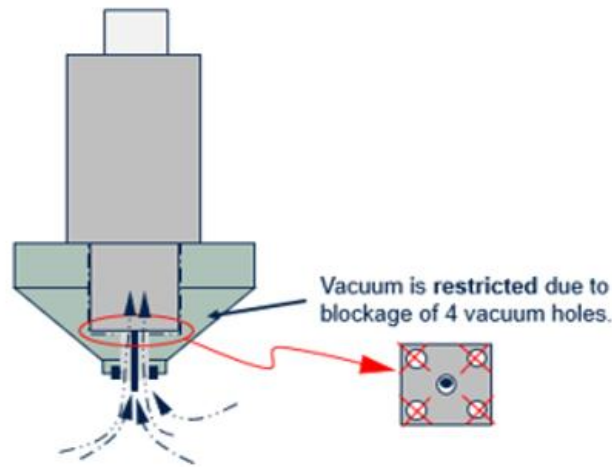


Fig. 4. Z-picker attached with flat design vacuum pad

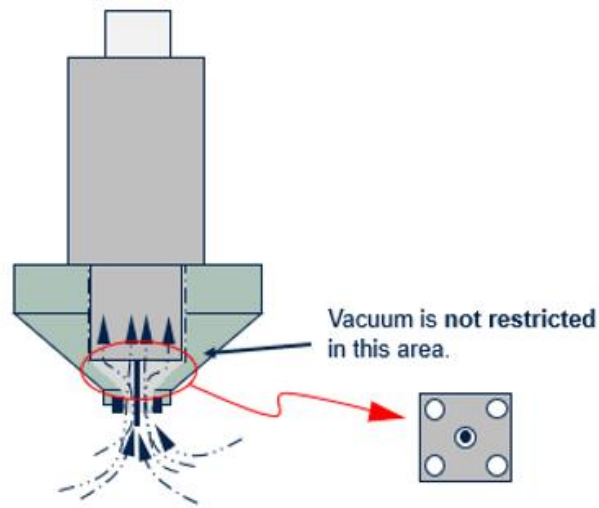


Fig. 5. Z-picker attached with tapered design vacuum pad

All the vacuum holes were open and effective on vacuum suction of units. Without units, vacuum pressure is low which triggers the machine to error. Vacuum readings from the machine that dictates acceptance of units to pick and place were true and real time.

#### 4. CONCLUSION AND RECOMMENDATIONS

Results and discussions of the actual usage and installation of the vacuum pad to the Z-picker have led the authors with the conclusion that tapered design of vacuum pad is more effective on vacuum suction than the flat design. Though flat designs have more rigid walls, tapered vacuum pads was evident to be more reliable in reduction of unit dislodge occurrence.

The authors therefore recommend the use of the tapered design of vacuum pads specially for large packages. The authors also recommend the modification of flat vacuum pad design in a way that all the vacuum holes will not be restricted for vacuum suction. Eventually, flat vacuum pad design and tapered vacuum pad design should also be compared in terms of application areas, advantages, ease of use, cost, etc, for added analysis. Studies and works discussed in [1-6] are helpful to improve the package singulation process. Vacuum pad designs and studies in [7-11] done for pick and place of Silicon die instead of the singulated package could also offer useful ideas for singulation process application.

#### DISCLAIMER

The company name used for this research is commonly and predominantly selected in our area of research and country. There is absolutely no conflict of interest between the authors and company because we do not intend to use this company as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the company rather it was funded by personal efforts of the authors.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

#### REFERENCES

1. Cabading Jr. P, et al. Systematic approach in testing the viability of mechanical partial-cut singulation process towards tin-plateable sidewalls for wettable flank on automotive QFN technology. IEEE 18th Electronics Packaging Technology Conference (EPTC), Singapore. 2016;254-258.
2. Zainuddin I. An introduction of strip chopping cut method to establish a robust strip based dicing process on tape dicing concept. IEEE 38th International Electronics Manufacturing Technology Conference (IEMT), Malaysia. 2018;1-7.
3. Buera MV, et al. Maximizing the process capability of singulation machine by dual work piece cutting on circular tape frame. Journal of Engineering Research and Reports. 2021;20(7);51-55.
4. Sumagpang Jr. A, et al. Tool setup improvement for package scratch mitigation at end-of-line process. Journal of Engineering Research and Reports. 2020;12(3);1-5.
5. Eng TC, et al. Methods to achieve zero human error in semiconductors manufacturing. IEEE 8th Electronics Packaging Technology Conference (EPTC). Singapore. 2006;678-683.
6. Buera MV, et al. Proactive verification of strip Y-index to mitigate gross misaligned cut due to mismatched unit pitching. Journal of Engineering Research and Reports. 2021;20(7);12-19.
7. Koepp R, et al. Achieving high speed RFID die pick and place operation. 33rd IEEE/CPMT International Electronics Manufacturing Technology Conference; 2008.
8. Sumagpang A Jr., et al. Pick and place process defect mitigation on semiconductor BGA device. Journal of Engineering Research and Reports. 2020;17(3);1-5.
9. Rodriguez R, Gomez FR. Pick and place process optimization for thin semiconductor packages. Journal of Engineering Research and Reports. 2019;4(2);1-9.

10. Kahler J, et al. Pick-and-place silver sintering die attach of small-area chips. IEEE Transactions on Components, Packaging and Manufacturing Technology. 2012;2(2).
11. Huang HH, Wey J. Research on the high-speed pick and place device for die bonders. 8th IEEE International Conference on Control and Automation. 2010;2(2).

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