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Pattern Recognition System Program Advancement to Compensate Strip Expansion on 1-Map Strips

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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

Package singulation process is where the whole strip was sheared to produce individual units. Existing singulation program for 1-map strip have only six (6) pattern recognition system (PRS) points along the whole strip with 240 mm length. Considering the length of the strip, it is prone with misalignment especially when the unit pitching is small. Due to a big gap of PRS points, the compensation of unit pitch has a significant variable value due to strip expansion that results to misalignment when not monitored. PRS works to calculate and compensate the appropriate alignment of the strip including the unit pitching. Distance between adjacent PRS points divided by the number of cut lines it covers results to the unit pitch. The lesser accumulation of strip expansion, the more it compensates and align with the actual unit pitch. Modification of PRS Program to add PRS points along the strip in order to lessen the distance between adjacent PRS points were made and results were promising compared with the existing with only 6 PRS points. It has been found out that unit pitch varies by adding PRS points that will compensate the expansion of the whole strip.

Keywords: 1-Map strip; misaligned cut; package singulation process; pattern recognition system; PRS; strip expansion.

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1. INTRODUCTION

Singulation process is where a strip consists of thousands of units were being sawn. The process efficiency of singulation relates to the accuracy of dimensions of the individual units produced after sawing. In order to produce good units, alignment is the highest factor to be considered [1,2]. Alignment references were required during programming to teach the machine on the strip alignment and a unique pattern for the pattern recognition system (PRS).

Existing program available on the production line only have 6 PRS points. These PRS points only calculate the strip considering the distance from start to middle of the strip and the other half to be from the middle to the end of the strip [2,3].

Assembled strips on the production line were often observed with strip expansion caused by the series of heat process steps that was required for the unit reliability. However, the 6 PRS points was verified not enough to consider the strip condition. Ideal unit pitching that was not appropriate with the actual unit pitching measurement of the strips results to misaligned cut units without alerting any machine errors [3-5]. PRS recognized that the strip was still aligned considering the start, middle, and end of the strip but did not consider finer alignment which ignored the effect of strip expansions.

Through the data that the authors have on hand, a study was conducted aiming to establish an improved singulation program that would cater to process strips with expansion without improvising the quality of the units.

2. METHODOLOGY

The authors were enthusiast to find and introduce a singulation program for 1-map devices that can cater strips affected with strip expansion and minimize the effects of misaligned cuts. The authors have come into series of discussions about the importance of PRS to produce good alignment with strip. The authors have also explored the program teaching for the efficiency to address the compensation of strip expansion. Works and learnings discussed in [1-7] focusing on the singulation process, design, and pattern recognition improvement were helpful in this study. Lastly, the authors have applied the best solution found upon completing the study.

2.1 Singulation Process Flow

Singulation process performance was important on the singulated unit output responses in terms of package dimension and package centrality. Block diagram to show the process flow of singulation from strip loading to unloading is shown in Fig. 1.

Upon loading of the strips into the chuck table, the machine will next perform the alignment checking with the strip, where PRS takes place. When the strip was verified to be aligned and acceptable as per parameter limits on the machine, the strip will proceed into cutting. After the strip has been sawn, the strip will undergo washing to remove the singulation dust induced at process. Monitoring buy-off measurements were performed to verify the cutting quality as time goes on.

2.2 Understanding the Importance of PRS for Singulation Program

PRS is a part of the machine program at singulation where its reference points that were set at the machine were measured in relation with each other. These PRS points helps on the calculation of the alignment of the whole strip with respect to the allowable limits of

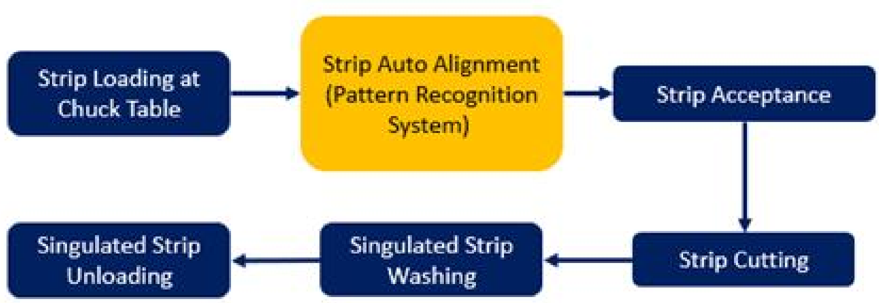

Fig. 1. Block diagram for singulation process

displacements and thetas that prevents the units to be misaligned cut. Unique pattern on the strip should have no likeness with other strip parts as PRS requires that no same pattern to recognize within the PRS search window area during alignment.

PRS points refers to the alignment of the strip. Alignment reference of the strip must consider the start until the end of the strip. Movement was from left to right. Shown in Fig. 2 is the alignment reference from the start of the strip until the end of the strip.

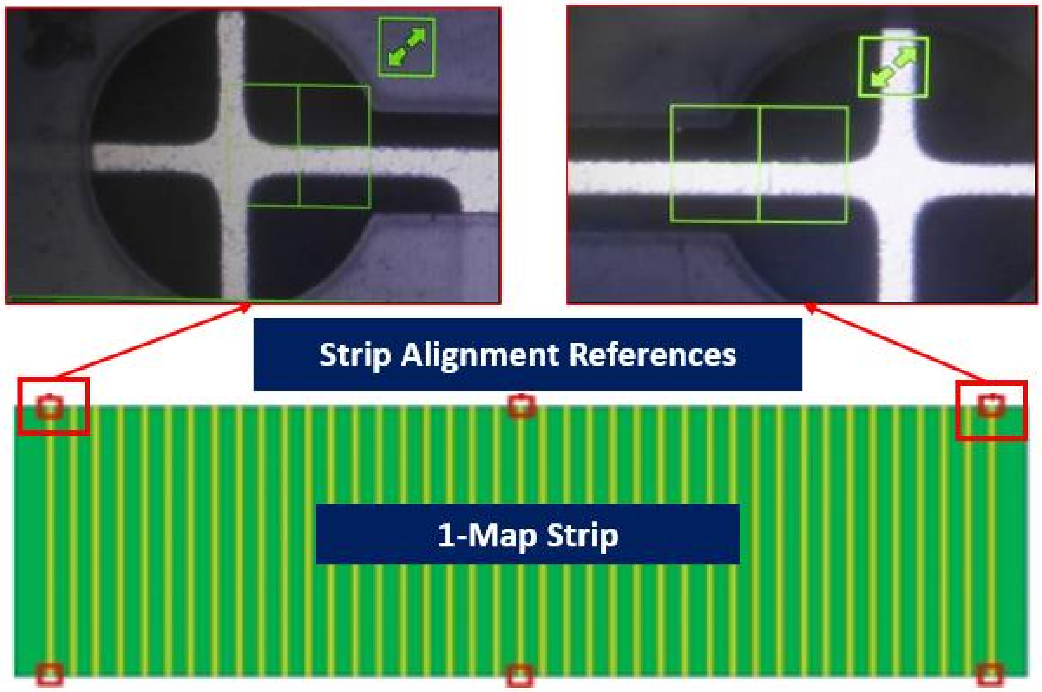

Fig. 2. Alignment reference from start to end of the strip

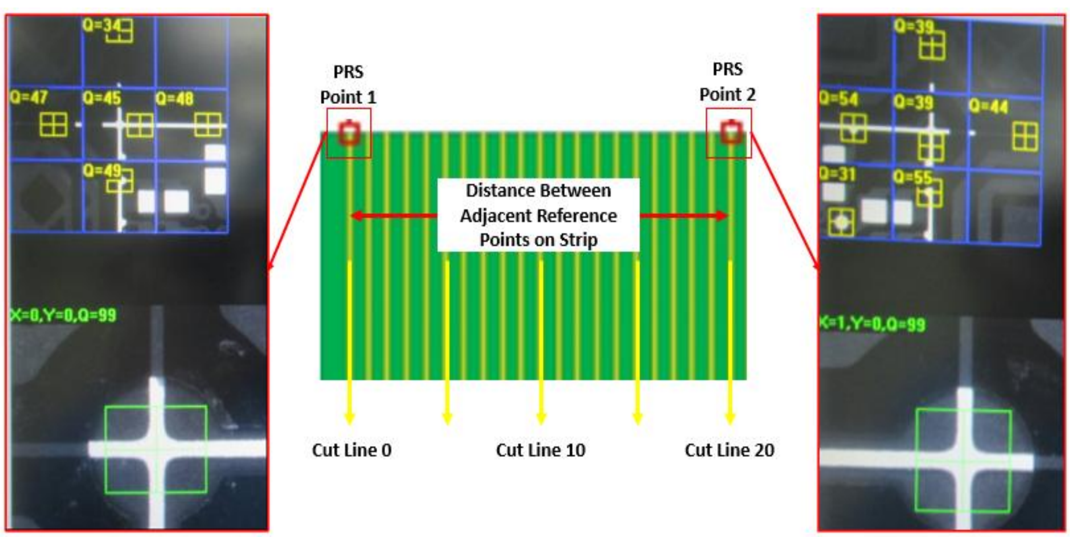

Fig. 3. PRS calculation for unit pitching

PRS also calculates the appropriate unit pitching of the cut lines in between PRS points. Unit pitching will be calculated by dividing the number of cut lines that the two PRS points covered to the total distance between adjacent PRS points of the strip. Fig. 3 reveals the two adjacent PRS points where PRS point 1 is the start of the strip and PRS point 2 is the middle. Boxes in blue is the actual PRS. Cut lines that these PRS points cover is 20 cut lines. Distance between PRS points divided by 20 cut lines is the unit pitching.

However, longer distance between the PRS points would also accumulate the strip expansion observed in each cut lines. Accumulation of strip expansions adds distance between the two adjacent PRS points which when divided with the number of cut lines it covered, resulted to mismatched unit pitching. Thus, resulted with misaligned cut output response on the units.

Upon understanding the importance of PRS points with regards to its association with the strip alignment and unit pitching, the authors have proceeded on evaluating the response of modified PRS program with additional PRS points. The evaluation aims to modify the PRS program to compensate with the strip expansions on 1-map strip.

3. RESULTS AND DISCUSSION

3.1 Modified PRS Results on Strip with Additional Reference Points

Existing PRS program setup consists of only 6 points which targets only the 2 points on start, 2 points on middle, and 2 points on end of the strip. The distance between two adjacent PRS points were long that misses to compensate the strip expansion of every cut line but accumulate it instead. The distance between the two adjacent PRS will be divided to the number of cut lines that it covers which results to the unit pitch. Half of the strip were considered on the existing program which have long distance between PRS points thus more accumulation of expansion. Thus, computed average unit pitch is not appropriate with the actual unit pitch.

Modified PRS program has more PRS points along the strip. Distance between the adjacent PRS points were shorter which compensates the strip expansion. Narrower distance between PRS points covers few cut lines where accumulation of expansion is finer. Application of the modified PRS program have observed that the unit pitch from the first cut line to the last cut line of the strip has minimal deviation on the actual unit pitching which will lead to a good quality of cutting the units. The less the gap between the PRS points, the less the compensation of the cumulative unit pitch to be computed. Application of the modified PRS program have resulted for the strip to have consistent unit pitching even with strip expansion. It has been verified through vertical indexing (y-indexing) that cutting is aligned with the actual unit pitching of the strip and this was compensated with the PRS. The comparison between the existing and modified PRS points is highlighted in Fig. 4.

With the results between the comparisons of existing and modified PRS program setup, it has been found out that lesser accumulation of cut line expansions and lesser cut lines to compensate have minimized the risk of the strip to have misaligned cuts. Using the modified PRS program, unit pitch of the program has minimal deviation with the actual unit pitch of the strip as PRS have already compensated and considered the expansion of the strip upon calculation and measurement.

3.2 Advantages and Drawbacks of Modified PRS Program Setup

Modified PRS program setup was found to be advantageous in terms of unit cutting alignment. PRS is essential with singulation as it calculates and compensates the actual strip measurement and condition in relation with the limits set on the machine. Application of the modified program mitigates the risk and occurrences of misaligned cut brought about by the strip expansion.

The only drawback that was observed through this study is the additional time consumed with multiple PRS points. However, drawback is negligible when compared with the time spent to assist the machine upon encounter of cutting misalignment.

Results and discussions of the study have led the authors to come up with the conclusion and recommendations in relation to the use of modified PRS program setup.

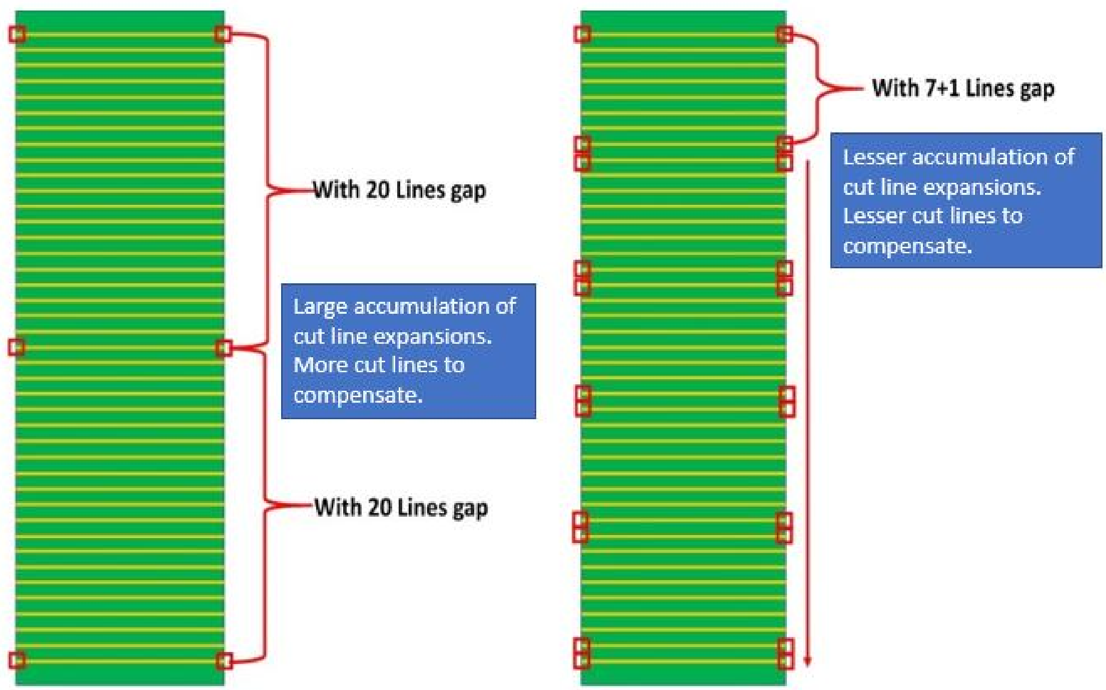

Fig. 4. Existing PRS program setup (left); and Modified PRS program setup (right)

4. CONCLUSION AND RECOMMENDATIONS

With the study conducted, the authors would like to conclude that the occurrence of gross misalignment brought about by strip expansions that cause the actual strip and machine program unit pitching misalignment can be prevented upon PRS programming modification. Advanced PRS program setup can help on the compensation of strip expansion as the program has lesser cut line expansion accumulation and lesser cut lines to compensate.

It is highly recommended for use in all other devices the PRS programming modification on 1-map strip to compensate for any expansion of the strip. Moreover, works and learnings shared in [8-11] would help attain assembly manufacturing process and design robustness.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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