CASE STUDY

Moving From Static Limits to Dynamic Part Average Test (PAT) Limits

Saves Production Scrap While Also Improving Product Quality

KEYSIGHT

PATHWAVE

Organization

- A High-Volume Automotive Microcontroller Manufacturer

Challenges

- Improve equipment efficiencies without affecting the quality of device test process

Solutions

- PathWave Manufacturing Analytics (PMA)

Results

- Reduction of greater than 2% in the total false rejects, unnecessary scrap
- Overall Equipment Efficiency improved more than 2%

The current chip shortage in 2021 is expected to continue to put a strain on semiconductor and IC manufacturers despite them investing more in capital expenditure to increase manufacturing capacity, and which may, in the best case, take a few years to stabilize. There has already been challenges meeting customer demands and deliveries and those delays have caused further problems downstream with at least one car manufacturer temporarily shutting down car production lines due to part shortages. The challenge now is to deliver more components with the existing fully utilized equipment until that new capacity comes online.

As an example, a high-volume automotive microcontroller device manufacturer had the challenge of improving equipment efficiencies while at the same time not affecting the quality of the device test process. The successful and fast deployment of PathWave Manufacturing Analytics into production had helped them improve not only their overall equipment efficiencies, with a higher overall throughput, but also maintained the quality of the device test process and further reduce the extremely costly scrap due to false failures and retest. Using the PathWave Manufacturing Analytics solution was a transparent change to the production process that lead to tangibly significant business outcomes, such as cost savings and a lower cost of poor quality.

The Challenge

A high-volume automotive microcontroller device manufacturer wants to achieve higher overall throughput through equipment efficiencies without affecting the device testing process. The process step was already reporting a CPK of greater than 2 (CPK = 2.0 = 6 Sigma).

General description of the original static production test flow:

1. The test equipment uses Static Part Average Testing (PAT) limits, according to the AEC-Q001 Guidelines for Part Average Testing, to determine a pass or fail for each device under test. The Static PAT limits are tighter than the device specifications which does allow for the limits to move around but it needs to consider lot to lot variation making the limits wider than they could otherwise be.
2. The process to determine the Static PAT limits for each lot takes production time away from the testers. This is done at the start of a lot with golden good devices because post-processing of the devices is not possible within the continuous flow of the production line.
3. Any significant drift of the measurements for the devices within the lot may cause unnecessary failures, false rejects, and will result in a retest to confirm whether they are really good or bad.
4. Bad devices are scrapped if their total number in the lot does not exceed the statistical bin limits. If there are too many bad units it will require a shutdown of the equipment and an investigation into the reasons why so many are failing.
5. The same production line is used to retest the devices a second time as they are routed back to the handler after they fail the first time.
6. The test equipment consists of a handler and within it there are multiple arrayed device testers to test the devices in parallel. Each of the device testers can be individually turned off if they experience a problem or if they are showing a high device failure rate compared to other device testers in the handler.

The Solution

The challenge of improving equipment efficiencies while at the same time not affecting the quality of the device test process was overcome by implementing pseudo real-time Dynamic PAT limits instead of the per lot Static PAT limits process.

For a single handler, the PathWave Manufacturing Analytics solution is processing approximately 1300 different Dynamic PAT limits every 3 seconds. The test equipment allows input of Dynamic PAT limits and can be changed on-the-fly as it is testing devices, in this case applying the approximately 1300 limits in one go. The Dynamic PAT implementation is based on the AEC-Q001 guideline.

By allowing the test equipment to update its limits, during the testing process, they can be shifted as the measurements of devices within the lot drift up or down, refer to figure 1. The outcome is that anomalous device measurements that are significantly different from the rest of the lot are still flagged while at the same time not causing as many false rejects vs the Static PAT method, due to the ability of the limits to move within the specification limits and catering to some of the process drift. This resulted in a reduction of greater than 2% in the total false rejects, a reduction of unnecessary scrap, a reduction of device handling, and improved equipment throughput due to the lower retest rate.

General description of the new dynamic final production test flow (changes in steps 1 and 3):

1. The test equipment used Dynamic Part Average Test (PAT) limits, according to the AEC-Q001 Guidelines for Part Average Testing, to determine a pass or a fail for each device under test. The Dynamic PAT limits are tighter than the device specifications which does allow for the limits to move around but within the upper and lower specification limits.

2. The process to determine the Static PAT limits for each lot takes production time away from the testers. This is done at the start of a lot with golden good devices because post-processing of the devices is not possible within the continuous flow of the production line.

3. Any abruptly significant changes in the measurements for the devices within the lot may cause unnecessary failures, false rejects, and will result in a retest to confirm whether they are really good or bad.

4. Bad devices are scrapped if their total number in the lot does not exceed the statistical bin limits. If there are too many bad units it will require a shutdown of the equipment and an investigation into the reasons why so many are failing.

5. The same production line is used to retest the devices a second time as they are routed back to the handler after they fail the first time.

6. The test equipment consists of a handler and within it there are multiple arrayed device testers to test the devices in parallel. Each of the device testers can be individually turned off if they experience a problem or if they are showing a high device failure rate compared to other device testers in the handler.

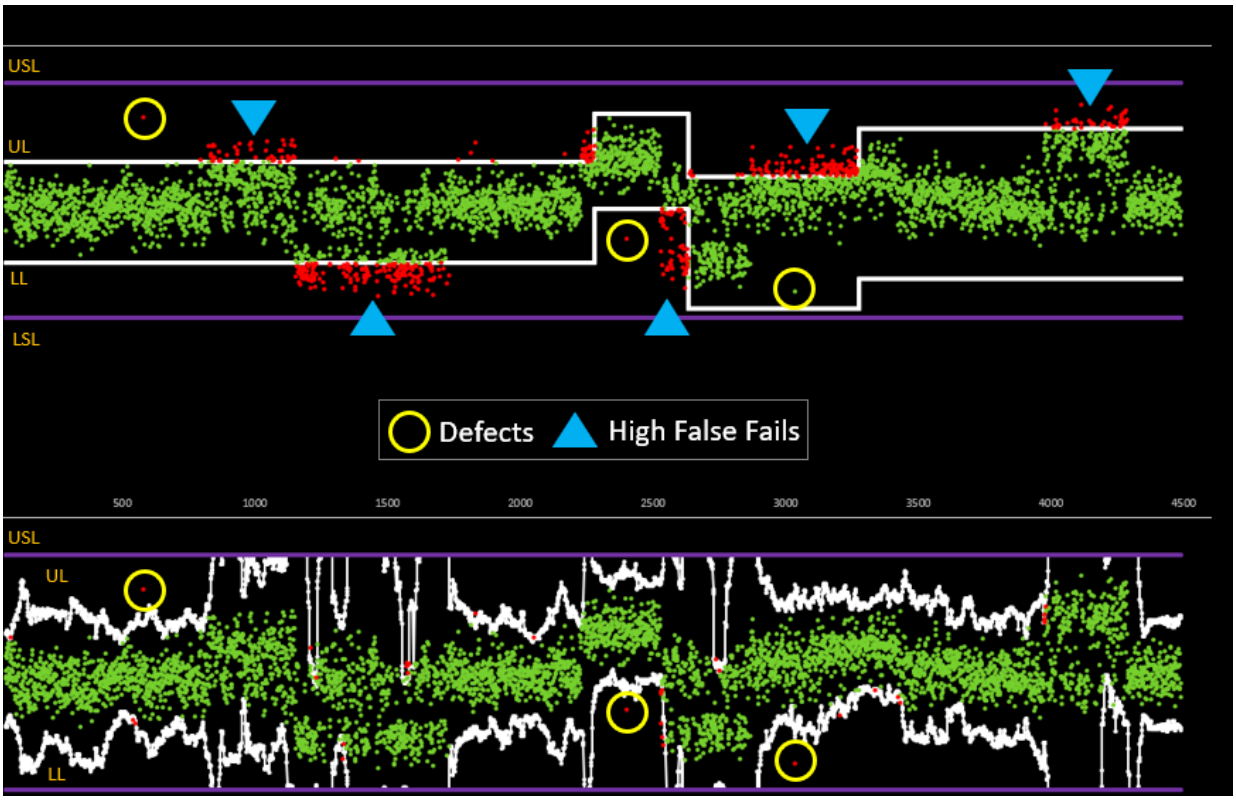

Figure 1. Static limits vs dynamic PAT limits.

The Results

PathWave Manufacturing Analytics helps to monitor the production line data and provide the near real-time feedback needed to keep the Dynamic PAT limits updated for the device test equipment. This helped to reduce the amount of retesting when compared to the previous Static PAT limits process that had caused a comparatively higher volume of false rejects and scrap. As a result, the overall equipment efficiency improved more than 2%, without affecting the quality of the device test process, which means that a higher volume of quality components can be shipped to customers faster.

For More Information

To find out the latest on PathWave Manufacturing Analytics, go to:
www.keysight.com/find/pathwaveanalytics