CASE STUDY

OPTIMAL+
Manufacturing Intelligence

Broadcom® Leverages Optimal+ IIoT Solutions to Improve Product Yield Recovery, Quality and Supply Chain Visibility

This case study is a summary of Gary Eves' Corporate Forum Presentation at ITC 2012

BROADCOM

Broadcom Corporation is a global leader and innovator in semiconductor solutions for wired and wireless communications. The company's products seamlessly deliver voice, video, data and multimedia connectivity in the home, office and mobile environments, with 99.98% of all network and internet data traffic crossing through a Broadcom chip.

Starting in second half of 2010, Broadcom embarked on a path to improve their qualification process for all of the mobile and wireless products in the company. While Broadcom was already one of the world's leading semiconductor vendors, and a pioneer in the fabless business model, they realized that the engineering challenges involved in monitoring the testing of hundreds of different parts at multiple fabs and package houses throughout Asia was becoming very difficult to manage well. With over 5 million devices being shipped every day, Broadcom recognized the need to take a new approach to test management, one that included a comprehensive data infrastructure that incorporated the latest advances in test management automation.

Thinking Out-of-the Box

Historically, Broadcom's project engineering teams held monthly yield meetings and used existing tools to analyze product yield over the prior 30 days. It was in these meetings that they would discover operational issues such as a bad load board had killed over 10% of their product yield for the prior month. Their OSATs would be quick to react to the problem, but that would not recover the yield that had already been lost.

In fact, Broadcom had overseas engineering teams deployed at their OSATs whose role was to monitor hardware yields from e-test to wafer sort and final test. However, with over 5 million units per day being produced, comprised of hundreds of different part numbers, it had become difficult for these teams to effectively monitor product yields in a timely fashion.

Another challenge was Broadcom's entry into the automotive market segment which required the company to perform Part Average Testing (PAT) to improve product quality and lower their Defective Parts Per Million (DPPM), a necessity to be qualified for automotive design wins.

For these reasons the Broadcom engineering organization turned to Optimal+ for their IIoT solutions that would address these manufacturing challenges in their diversified supplier base.

"Based on the closed cases from the HW yield excursions that we were able to [identify with Optimal+] we actually realized our ROI for the year in the first 7 months."

Gary Eves, Director of Product Engineering Operations, Broadcom

Implementing Optimal+

Broadcom's Project Engineering Group began to deploy Optimal+ across their entire global supply chain in 2011 making it the primary back-end yield analysis solution for Broadcom and their supply chain, running in multiple fabs, package houses and test houses across Asia.

The integrated solution provided many immediate benefits to Broadcom:

- **Support for control rooms at global test sites** – Broadcom needed to be more efficient with their testers when not doing development work, and with Test Floor Operations, they were able to run low volume production to provide earlier silicon access to their customers.
- **Support for Part Average Testing (PAT)** – Global Operations provided Broadcom with the supply chain integration and robust analytic capabilities necessary for their engineers to search for and eliminate systematic issues that were affecting the quality of shipped parts.
- **Increasing efficiency at the OSAT vendors** – Every load board and probe card in Broadcom's supply chain test fleet was running automated Optimal+ rule sets for site-to-site, first pass yield and final yield, enabling their engineers to see data that they never saw before.
- **Skip bin analysis** – Optimal+ made it very easy for Broadcom to determine which bins were not recovering under retest so that they could be put into a non-retest bin. This allowed Broadcom to achieve higher throughput at their testers with the same final yield.
- **Preventative Maintenance (PM) tracking** – Broadcom could now track exactly what PM was done for a given wafer lot. This enabled Broadcom to clearly understand what the trends were for tester maintenance and how every type of PM impacted yield for all of their devices.
- **Gap reports** – Broadcom has internal goals limiting how much yield can be picked up on retest from wafer probe to final test. Global Operations enabled project teams to determine where too much yield was being reclaimed, providing clear targets for test program improvement.

In addition, there were several longer term benefits that Broadcom achieved through the use of Optimal+:

- **Reducing the Overall Cost of Test** – With the data collected by Optimal+, Broadcom was now able to calculate a standard metric for Overall Engineering Efficiency (OEE) across all of their OSATs which allowed them to compare all of their suppliers with normalized data, and negotiate prices accordingly.
- **Ability to establish Statistical Bin Limits (SBL)** – Broadcom has wanted to do SBL for many years, but was only able to realize this capability with Optimal+. Now Broadcom can do this for their wafer-level packages (BGA and CSP), products targeted for the automotive market and for specific customers that demand SBL for products that Broadcom makes for them.

Rollout process

Broadcom deployed Optimal+ in multiple phases over a six-month period:

- **Set up the global IIoT infrastructure and system integration** – This was a key step because of differences (e.g. time zones, cultural etc.) between Broadcom and their OSATs. The Optimal+ field organization was key to coordinating and resolving these differences between Broadcom and their suppliers.
- **Proxy deployment, data collection and data augmentation** – In any IIoT deployment, the data completeness and relevancy are crucial to ensure the right decisions are made. This was a very important step and major proof point for Broadcom – to trust all of the data that was being collected by Optimal+.

As part of all customer engagements, Optimal+ provides application engineers and IT support personnel at both the semiconductor vendor and their OSAT suppliers to ensure that all test data is collected accurately and completely before any action is taken.

- **Data analysis and rule settings for selected products** – Because of the size of Broadcom's product portfolio, it was determined that they would initially run Global Operations on a limited set of products to get the Operations team comfortable with the data analysis and rules that were now available to them.

Because Global Operations runs in parallel with all existing test programs, Broadcom's entire legacy system could continue to be used as Optimal+ was being phased in.

- **Rollout to all products** – Once the Operations team was comfortable with the usage model for Global Operations, the solution was rolled out to include all product lines at Broadcom, over two billion units per year.
- **Establishing an internal Optimal+ team in Asia** – This was a key step for Broadcom, creating an engineering team responsible for Optimal+-related operations, rule creation and communications with their OSATs.

Achievements in the Rollout Process

- Global Operations was running across Broadcom's entire supply chain and covered all product and business lines
- Complete test data was being collected: Wafer Acceptance Test, Wafer Sort and Final Test
- Broadcom was running dozens of population-based global rules 24/7
- Part Average Testing was being performed for their automotive products to drive higher quality
- Hundreds of engineers from multiple disciplines were using Global Operations (product & test engineering, foundry engineering and design engineering)

Success Summary

Through the use of the Optimal+ IIoT solutions, Global Operations for Semiconductor and Test Floor Operations, Broadcom was able to optimize and automate the detection of operational issues in their supply chain, reducing detection time from 30 days to less than an hour to discover yield improvement opportunities. The robust graphical reporting capabilities in Global Operations enabled Broadcom's engineers to quickly determine the root cause of an issue whether it was due to a probe card, test site or a test program, allowing them to rapidly resolve the issue with their OSATs and maximize product yield and throughput.

The speed at which Broadcom was able to cut off yield excursions based on these triggered events drove significant improvements in operational performance and resulted in achieving their annual ROI goal in the first seven months. In just the area of test program optimization, the use of Global Operations enabled Broadcom to improve the closure rate of test program issues from less than 2% to 29%, primarily due to their ability to find the source of the problem, something they could not do prior to the deployment of the Optimal+ IIoT Data Architecture.

In addition, Broadcom was able to implement an automated safety net to prevent low-level DPPM issues from reaching their customers which was essential to ensure high levels of quality for their wafer-level CSP and BGA devices as well as products targeting the automotive sector.

Broadcom continues to use Optimal+ IIoT solutions across all of their business units and product lines and is currently running in excess of 5 million units a day through the Global Operations solution.

For more information, please visit: **www.optimalplus.com**

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