Automated Data Management & Analysis (ADMA)

Contract Assembly Production, Materials & Equipment
Data Tracking & Management

E-BOOK

PALOMAR
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Background Information

Complex assemblies may take multiple days, more than one shift and more than one operator to complete. ADMA enables complete pass-down continuity, or closed loop actions, from person to person and from shift to shift.

Closing the Production and Process Build Feedback Loop
At the heart of traceability and best practices are all the details in between the beginning and end of the project. Tight process control is constantly monitoring to quickly identify the location of the deviation, isolating the issue and removing it, or reworking if the problem is systemic. The feedback loop indicates what is working and what is not. If a there is a minor crack in this loop, valuable information is at risk of being lost which can jeopardize schedule and customer satisfaction. Closing this loop, sealing it tight, and managing the device assembly details on a day-to-day basis is imperative.

For example, with wafer scale packaging on the rise and increasingly smaller die populated on wafers, continuity of work—in conjunction with the feedback loop—becomes essential. A key feature of ADMA is the overall improvement in the supply chain. In a wafer scale packaging process where ADMA is absent, chipped or problematic die have to be manually spotted and removed, or they are otherwise skipped over. With ADMA, not only are these problems located immediately, but they are also mapped, tagged and addressed. In a multiple shift operation, the ADMA software automatically stores the previous work, therefore eliminating duplication. This translates into faster turnaround times and quicker time-to-market for customers.
ADMA – What is it?

Reliable process control is assured with ADMA through the continuous verification of operational data against process documentation and control limits. This also enables multiple equipment sets and applications to be interleaved for better time and resource utilization without a sacrifice of quality.

WHAT IS ADMA?
Automated Data Management and Analysis (ADMA) is a unified system that improves all aspects of process development and assembly life cycle, reducing costs through increased yield and improved resource utilization. ADMA is unique to Palomar Technologies Assembly Services™.

ADMA automatically collects data exported from the automated assembly equipment’s core software and sends it to an analysis application.

ADMA then creates graphical and numerical analyses of the performance data, which can be output for monitoring and further analysis, e.g., with SPC software and component traceability.

ADMA Supports
• Multi-platform/data sources both PTI and 3rd Party support
• Standardize tools and methodology

Download the Assembly Services data sheet.
Continued Uptime, Decreased Production Disruptions, and Faster Data Recovery

Contract assembly is all about production, uptime and yield. When ADMA was conceived, its engineers deemed that it was not wise to put production equipment on the corporate network. In response, engineers created BonderNet with a dedicated server, referred to as “Rome Server”, thus applying the phrase “all roads lead to Rome.” This architecture ensures a more controlled and secured IT environment for the specialized equipment.

All process data and instructions can be equally accessed from any of the computers in the lab. The inherent redundancy of the access point architecture means if one goes down, production will continue uninterrupted, as shown to the right.

The “Rome Server “ensures that all access point PCs and all machine configuration data are backed up and available for immediate recovery.
ADMA Time-Stamped Directories

All data is categorized and stored in time-stamped directories, down to the (ms) for sufficient granularity (see Figure 1), allowing for both time- and event-based trending of key variables to maintain a clear picture of process status. Process and equipment performance data can be viewed across multiple applications, multiple locations, multiple machines and multiple platforms of Palomar Technologies equipment.
### Example Machine Data – 8000i Wire Bonder

<table>
<thead>
<tr>
<th>Subsystem/Test</th>
<th>Machine</th>
<th>Machine Validation</th>
<th>PTI</th>
<th>Process</th>
<th>Customer</th>
<th>Periodic Machine Validation</th>
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</thead>
<tbody>
<tr>
<td>8000i Wire Bonder</td>
<td>Configuration</td>
<td>Calibration</td>
<td>Diagnostics</td>
<td>Motion</td>
<td>ZL Preload</td>
<td>Force</td>
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<tr>
<td>Electrical</td>
<td>Servo Tuning</td>
<td>Cross-Axis coupling</td>
<td>Servo accuracy</td>
<td>XYZl Holding</td>
<td>Touch</td>
<td>Position invariant servo accuracy</td>
</tr>
<tr>
<td>Mechanical</td>
<td>Tool Offset</td>
<td>N-Position Test</td>
<td>Leveling / deRocking</td>
<td>Vision</td>
<td>Zr/Zl Stability</td>
<td>Vision</td>
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<tr>
<td>Facilities</td>
<td>Vision - pixel size / orientation</td>
<td>PR with Move</td>
<td>ZL Bearing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Force</td>
<td>Wire Test</td>
<td></td>
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</table>

<table>
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<tr>
<th>Results are:</th>
<th>interpreted</th>
<th>manual</th>
<th></th>
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<th></th>
<th></th>
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</thead>
</table>

- Divide and conquer the machine/process with tools to collect, analyze and view the data
- Basic breakdown of electro-mechanical setup, calibration, validation, basic process capability, initial customer process capability and then 24/7 capability correlated to machine performance
Key Advantages to Using ADMA

- Maintenance
  - All calibration and diagnostic data are time stamped, centrally analyzed and trended
  - Useful for analyzing machine failures and to predict preventative maintenance

- Process Development
  - Tying of machine performance to process performance through data storage and analysis

- High-mix/Low-volume OR Low-mix/High-volume
  - Comprehensive data management
  - Build tracking

- Ramping to production
  - Scalable data management and analysis

- Production
  - RAM Statistics
  - Runtime data logging, i.e. PPAC and deformation
  - Complete traceability
Data Management

1. All data is categorized and stored in time stamped directories, down to the (ms) for sufficient granularity.

2. Multi-platform, multi-serial number, multi-data source, multi-time-stamped comparison between machines and over time.

3. Common viewer the data from all platforms.
Standard Tools and ADMA

More detailed view of the machine data model: shows commonality between platforms.

Data is the common thread among all of these.

This is data with a purpose.

Download the “ADMA: Paperless Lab” overview white paper.
Servo Performance of the axis in question and its impact on the other axes.
Diagnostics Axial Coupling

Position invariant servo performance.
Machine Validation XL Preload

Example of a machine validation test: standardized test that reveals a signature of an improper preload on the ZL axis.

Notice the band in the “bad” plot versus the “lack” of one in the “good” plot.

The time to run all the machine validation tests on an 8000 Wire Bonder in < 15min.
- Short time
- Lots of data
- Easy analysis
Die Attach Post-Placement Accuracy Check

~26000 bonds over a weekend, uninterrupted execution.

Accuracy check turning on.

Overall accuracy of the PnP ~2.14 um worse case scenario.
Trending of Maximum Position Error of Die Placement Centroid

This is an example of more PPAC data but comparing different executions of the same program, notice the time stamps.

This example displays grading lines on the trend plot and is representing that process was somewhat in control and then was lost.
Case Study #1

- **Company profile:** U.S. optoelectronic device manufacturer startup company

- **Challenge:** active optical cable application formatted for 6” wafer scale packaging. The company required microelectronic process development and production, but was not ready to commit to purchasing the required range of capital equipment.

- **Solution:** This customer absolutely required a contract manufacturer that could provide 100% part traceability and inspection. This was a stringent requirement to maintain tight process control of the 3000+ assemblies per wafer undergoing multiple assembly steps. Due to the immense amount of data from one wafer, let alone hundreds, ADMA became a key element to ensuring this customer’s success providing:
  - Efficient processing of the wafer—both assembly and inspection used wafer mapping for the 6500, 3500 and 3800 Die Bonders
  - Inspection data was compiled into a custom **Certificate of Conformance**
  - Costly mistakes were avoided using clearly documented instructions
  - Within a few repeat orders, Assembly Services quickly built a viable inventory and enabled the customer to ship known-good product to market faster

- **End result:** Without a paperless traceability system, Assembly Services could not have supported this particular customer. The post-measuring requirements were significant. The wafers were large and had thousands of sites.

The assembly process was complex, using multiple steps and multiple machines. Software automation significantly reduced risks of fundamental human errors. The customer gained business by meeting their customers’ expectations by providing good product in a timely manner.
Case Study #1 Results

Example of a Custom Certificate of Conformance

Build Process Tracking
Case Study #2

• **Company profile:** A global MEMS and HB LED device manufacturer requiring contract assembly support. With their six-month HB LED forecast build, they were prime candidates for ADMA. A new work flow was set up by the floor manager: shipping of parts work order flow tag (WOFT) traceability data for build duration of build.

The product was already prototyped but still required three weeks of process development to tailor it to small-scale production. Once process development was completed, the production began. A six-month forecast and purchase agreement was made. At the end of this term, the company’s management decided to shift focus elsewhere. Assembly Services wrapped up the job and archived all the build data.

• **Challenge:** Two years later, the customer came back with the request to re-start production. In a paper-reliant (non-ADMA) environment, restarting production would be labor intensive and costly, but possible. The product would likely have to be redeveloped. Any learning that took place two years prior would be incomplete, which equates to re-work. Attempting to validate information which may not have been well organized or thoroughly documented, locating documents, processes, programs and instructions would be time consuming, further pushing out lead times and time-to-market. In short, the wheel of the project would have to be reinvented to meet the same good results achieved the first time around.

But, this was **not the case; the customer was up and running almost immediately.** As a direct result of ADMA, this two-year dormant customer was back in production within days rather than weeks.

• **End result:** Because of the ADMA, the customer was the beneficiary of:
  - No redevelopment costs. Savings = $30K to $50K
  - No process related re-work costs. Savings = $15K or more
  - Actual time-saving(s) per task. Concise, detailed work instructions with package parameters, process flow, part specific programs, tool and time utilization data were available immediately. Savings = 15 production days
  - Total Savings: $45,000 - $65,000 + 3 (5) day production weeks

[Download the “ADMA: Paperless Lab” overview white paper.]
Case Study #2 Results

Example of WOFT (Collapsed Detail Step)

Example of Detailed Step in the WOFT
Case Study #3

- **Company profile:** Established USA defense contractor
- **Challenge:** assembling a newly patented Composite Focal Plane Array (CFPA) requiring precision epoxy die attach—video die on an Al Ni substrate. A class 1000 clean room space was required.

This project was too small and too specialized for the defense contractor’s current engineering and production environment. Yet, it was important enough to make an investment, develop a prototype and begin limited production for feasibility testing in military aircraft.

- **Solution:** Co-planarity of the video die array was imperative. The video die came in lots, with each lot often differing in height (+/- 3 um) that required the assembly process to compensate for this height difference. The WOFT indicates the required die and epoxy heights. The die was then picked and placed at a programmed height, force and time. While each array could be different in planarity, each separate array had to have the same co-planarity. Because ADMA housed the day-to-day assembly and process directions, technicians and operators were able to perform this work without a skilled engineer involved at every step. Before, during and after the assembly, the board was tested for shorts. After passive component attach, the board was tested again with a multi-meter for electrical soundness—all of the data was “pulled” into ADMA. ADMA can record and store ESD testing data—each particle count was pulled into the analysis picture for this project and delivered to the customer. If there was ever a problem, it was traceable and quickly fixed or re-worked.

- **End result:** Fluctuations in material are common and part of working in micron-level assembly. The customer was able to see, with data, that their vendor had supplied an improper adhesive material. The process was not the problem. Quickly, the vendor shipped out the correct adhesives. The substrate material was reinstated and the process was back online.

As work has continued on this project, the forecasts have been intermittent (a three-month forecasting build, dormant for two months, a six-month build, etc.). Nonetheless, it has been cost-effective with production data stored with ADMA to start up production as needed with minimal lag time.

Download the “ADMA: Paperless Lab” overview white paper.
Case Study #4

**Customer profile:** medical company requiring product-level traceability after having spent $1M on internal development and failed.

**Solution:** After adoption of ADMA, the customer was able to correlate multiple processes from different build steps in the complete build process of a component.

**End result:** Build tracking data flow component/packaging traceability.

Download the “ADMA: Paperless Lab” overview white paper.
Summary

• Data is KING

• Trending provides a historical perspective of the machine and process

• Machine validation allows for self diagnostics and correlation of machine performance to product quality

• ADMA allows for remote machine/process monitoring and diagnostics
Palomar Technologies, a former subsidiary of Hughes Aircraft, is the global leader of automated high-accuracy, large work area die attach and wire bond equipment and precision contract assembly services. Customers utilize the products, services and solutions from Palomar Technologies to meet their needs for optoelectronic packaging, complex hybrid assembly and micron-level component attachment. For more information, visit www.palomartechnologies.com.

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