SynqNet® Case Study

Semiconductor EFEM & Sorter Machines

Asyst Technologies, Inc. provides automation solutions optimized for the needs of global customers in the semiconductor, flat panel display, and related industries. To continue a leadership role in machine design around the goal of optimum productivity, Asyst did a comprehensive customer and marketing assessment of how the next generation equipment front-end module, or EFEM, should perform. Asyst engineers literally started the design process with a blank sheet of paper, and the Spartan™ EFEM was born. The goal of the Spartan EFEM project was to produce the most robust and flexible tool of its kind with a dual role as a general purpose wafer sorter as well. For the critical controls portion of the Spartan EFEM System, Asyst chose SynqNet® technology to ensure the motion requirements would not only exceed tight performance specifications, but also offer a clear upgrade path for future innovation. The outcome is a revolutionary tool with highly sophisticated robotic control that is changing the market for semiconductor EFEM requirements.

The Spartan EFEM was conceived completely with customer requirements behind the design. Important drivers include:

- The cost of real estate where an EFEM would typically be operated. The space is very valuable, therefore equipment manufacturers are driven to constantly push the limits between effective processes and the space to perform those processes.

- The speed and efficiency in getting wafers fabricated must always increase, but overall costs must decrease.

- Safety is all-important, as wafer handling is a high value product, and any error, especially in motion control, can equate to high dollar loss.

Design Innovation: The Spartan EFEM is one-half the volume of other tools of its kind and utilizes a high throughput dual end-effector Cartesian robot with optional edge grip aligners.

Asyst engineers developed the Spartan EFEM to go beyond expectations and set new standards in the marketplace. The result is an EFEM that is one-half the volume of other tools of its kind. Essentially, the EFEM must meet SEMI standards for equipment size to mount to an existing tool, but Asyst engineers were able to decrease the volume inside the Spartan EFEM and completely remove the bottom portion of the tool. The result is an area under the Spartan EFEM that the end-user can utilize for their own tooling requirements and the overall weight of the Spartan EFEM is greatly reduced. In addition, the airflow system is highly optimized and efficient in large part due to less air volume to manage.

With the most compact design of its kind, Asyst engineers needed to rethink robot design inside the Spartan EFEM. Again, with productivity optimization a top priority, the system had to be fast and accurate. Asyst decided on a high throughput dual end-effector Cartesian robot with edge grip aligners. The z-axis of the robot is side mounted and avoids the vertical space needed in Scara type wafer handling robots. With an advanced particulate control utilizing innovative air circulation and filtration, the Spartan EFEM design guarantees an ISO class 1 and better microenvironment option.

Another design change needed to remove the lower section of the Spartan EFEM was a new innovative loadport design, which ultimately reduced the overall cost compared to standard loadports and greatly improved tooling integration. The Spartan EFEM utilizes a rigid, proprietary frame design that greatly reduces the installation time on an existing tool. Unified structural points on the Spartan EFEM make loadport aligning intuitive and timely.

And with innovation and flexibility in mind, the Spartan system is also available as a general purpose wafer sorter for a variety of applications. This dual-purpose tool functionality allows Asyst to rapidly customize to meet the demanding needs of their customers.

Controls

With a very compact workspace, Asyst needed sophisticated path planning for efficient robot control. According to Mike Krolak, Senior Director Controls Technology, "The power and flexibility of the tools allowed us to do very sophisticated path planning and take advantage of the power of the MPI (Motion Programming Library C/C++) as the motion engine in our web-based GUI. Our GUI then provides our customers with an easy to use interface for operation, and allows the user to 'teach' the robot for their specific application."

Like most SynqNet applications, the motion controller must interact reliably with vision systems, I/O, and other feedback devices for precision and speed. "The architecture of the SynqNet systems fit perfectly with our specifications for client enabled motion applications, PC-based centralized control, host-level functionality, expandability, remote diagnostics, and powerful tuning tools all available over a digital network," said Krolak.

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Asyst requirements were clear that a digital motion network would be needed for the project. The obvious reduction in wiring and speed of wiring were obvious drivers in the decision. But the network also had to support a level of performance that would ensure the Spartan EFEM could deliver on the promise of optimum productivity, safety, and reliability. SynqNet technology was the clear solution.

SynqNet is a high speed motion network based the on the physical layer of Ethernet (IEEE 802.3) with a streamlined data layer and timing model to ensure synchronous operation across all nodes in a system. Service channel features like firmware configuration download and remote diagnostics coupled with high servo synchronous

update rates for all nodes, and fault tolerant operation gave Asyst the network they were looking for. Asyst chose an XMP-SynqNet-PCI based controller for the high performance tightly coordinated axes of the system, and custom dual-axis SynqNet servo drives were provided by Kollmorgen Servotronix group, Danaher Motion.

Danaher Motion Software Tools

"We placed great importance on remote diagnostic capabilities of the Spartan EFEM," continues Krolak. "With all of the MEI software tools being TCP/IP enabled, and operated as a client, we could run all diagnostic software remotely and get visibility all the way into the SynqNet drives and actual mechanics of the system. It was absolutely critical that we were enabled to run this way."

Asyst relied on the core MPI programming software libraries, the Motion Programming Interface (MPI) as well as real-time analysis tools like MotionScope™ for accurate motion data analysis. "MotionScope was absolutely essential for tuning the servo performance of the system," said Krolak. " I could literally 'see' data points like settling-time response and characterize this data and perform plot comparisons until I had a the result

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>
> Mike Krolak
> Senior Director Controls Technology
> Asyst Technologies, Inc.

I wanted. It was important that this data was real time, and gave me insight into what my tuning parameters were returning in terms of system performance."

Controls Toolkit

The ControlsToolkit featuring BodeTool and FilterDesigner was another tool used by Asyst engineers that enabled a level of machine tuning not seen before in other motion software packages. "The BodeTool took my level of visibility into mechanical response to a whole new level," said Krolak. "This was something I really never had before. With the straightforward Windows® based interface and a SynqNet motion controller, I could excite any axis or two axes simultaneously and see the frequency response of the system like never before. And since the Spartan EFEM host runs VxWorks, I could perform all analysis testing in client mode from a remote host. I was able to thoroughly test the system to ensure that any motion command would not destabilize the system and extract even greater motion performance through optimized tuning."

MPX (Motion Programming ActiveX®) software from Danaher Motion was also used in development and for production line testing. The MPX is an ActiveX enabled software package that allows programming in any ActiveX enabled environment. MPX allows production to quickly test the Spartan EFEM motion system and tuning parameters to quickly determine if there are any discrepancies in machine performance. And the ability to gather data remotely over standard TCP/IP connections gives Asyst flexibility in monitoring or analyzing data from any location.

Web-Based Philosophy

The Spartan EFEM controls and interface is based around an innovative web-centric focus. All controls are run via a standard web browser for setup, configuration, and diagnostic modes. The central host for control runs VxWorks for real-time performance that connects to a Windows-based operating system that runs a series of Asyst and software tools. The idea behind this web functionality is to take advantage of remote diagnostic capabilities from machine level to enterprise. The TCP/IP functionality in the software again coincides with the Asyst vision that machine information can be drawn out and passed to any worldwide location. Real-time data collected over SynqNet can be retrieved by the controller, passed to the machine host, carried over a secure network connection and analyzed remotely. The impact in predictive maintenance and field service gives the Spartan EFEM a clear advantage in terms of customer services, machine availability, and reliability.

The Spartan EFEM web-based configuration tools also harness powerful networking features that allow for remote configuration and setup. All user programming is done through an intuitive, ease-of-use GUI and the new interface allows for fast operation.

For more information about the Spartan EFEM, visit http://www.asyst.com.

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INTERESTGROUP

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