Elmo Motion Control

Fast Settling Servo Drives Speed Wafer Testing

Gain scheduling by profile enables the system to rapidly and automatically adjust parameters to support high-speed positioning with minimum settling time.

Abstract

Semiconductor fabrication requires a complex sequence of time-consuming steps using highly sophisticated and expensive equipment. The reason the microelectronics industry can deliver massive computing power at reasonable pricing is because of batch processing—the ability to fabricate hundreds of identical chips simultaneously on wafers the size of dinner plates. The economics of batch processing only hold if those hundreds of chips are operational, however. As a result, component testing is essential to support process control, quality assurance, and even standards compliance.

Testing begins with the patterned wafer, to identify any bad chips before they undergo expensive packaging steps. With individual devices measuring just millimeters across, test equipment needs to be precise, repeatable, and above all, accurate. Test systems also need to have the smallest possible footprint, because space in a semiconductor fab is always at a premium. Finally, the testing process needs to be fast enough to keep up with the output of the microlithography machines. When semiconductor test-equipment manufacturer Proaut Technology GmbH began to upgrade its PMA wafer-testing series, the goal was to achieve a throughput of 40,000 components per hour. The company met its goal using high-performance, high-efficiency servo drives from Elmo Motion Control.

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>
> **Mr. Thilo Wicht, CEO of Proaut Technology GmbH**

Elmo's values in this application

Making Smart Machines **Smarter**

- Perfect Servo
- Smallest & Lightest
- Efficient Power Conversion
- Highest Power Density
- Ruggedness
- Negligible EMI
- Utmost Reliability
- Easy & Simple to Operate
- Precise & Efficient Networking
- Utmost Safety

GOLD WHISTLE
HIGH VOLTAGE
(HV)

Miniature Servo Drive

Benefits

+ 30% increase in wafer throughput
+ Improved Move & Settle performance by Smart Control
+ Built in drive safety functionality to simplify machine
+ High efficiency, compact drives for smaller machine footprint
+ Ultrafast EtherCAT cycle times

Minimizing settling time

Before measurement can begin with the PMA, the wafer or panel needs to be installed in the test chamber. The PMA handling system uses a vacuum chuck to remove the component carrier from a magazine located next to the unit and place the carrier on a rotary positioning stage. The actual measurement system consists of the stage, a vision system to provide wafer position feedback, and optical and electronic measurement tips to acquire the actual test data. The stage is capable of nanoscale positioning in X, Y, and Z, and positioning in ϕ to a fraction of a degree. The camera can be positioned along the Z axis for autofocus. During the measurement process, the system tests sections of the patterned wafer sequentially, taking measurements and then advancing and aligning the wafer to place the next area beneath the measurement tips.

The challenge with quick move-and-settle positioning is that inertia may cause the load to overshoot and oscillate about the commanded position (given the high accelerations and small increments). This has the effect of either introducing measurement error or slowing down the measuring process. The initial PMA design was capable of a throughput of an astounding 30,000 components per hour. In order to achieve their target throughput of 40,000 components per hour, the Proaut engineering team needed a way to get higher performance out of their existing mechanics. They found it in the Elmo Gold Whistle family of servo drives.

Gold Whistle drives feature a function known as Gain Scheduling by Profile Status. In gain scheduling, an algorithm enables the system to define separate sets of controller parameters—proportional gain (KP), integral gain (KI), higher-order filter links, etc.—to optimize system performance for each of several distinct application conditions. During operation, the drive can automatically change from one set of controller parameters to another based on the working point of the servo drive. The filtering helps smooth the effect of changing controller parameters, leading to faster settling.

Efficient and compact

The Gold Whistle servo drives brought other advantages. The application involves highly coordinated motion. The wafer handling axis needs to coordinate with the positioning stage; the ϕ axis of the positioning stage must be tightly coupled with positioning in X, Y, and Z. This type of motion control requires high-speed, precise fieldbus connectivity. Gold Whistle drives are available with a choice of EtherCAT or CANopen. The ultrafast cycle times and minimal jitter of these protocols support best-in-class real-time performance.

Achieving this level of coordination requires a centralized control architecture using a master controller to manage operation of the drives for the individual axes. Controller and drives are installed in a centralized cabinet. The approach simplifies wiring and integration but it does present risks. Packing six drives into a small enclosed space traps heat that could potentially build up enough to degrade performance and cause early failure of the electronics. Downtime in the semiconductor industry can cost hundreds of thousands of dollars per hour, so the team needed to avoid this problem. Gold Whistle drives operate with a wall-plug efficiency of better than 99%, which minimizes the amount of heat that needs to be dissipated.

In addition to efficiency, the drives are also a good fit—literally. Their small size enables the use of a smaller cabinet, minimizing machine footprint. "The PMA machines are very compact, with a small internal switch cabinet," says Thiol Wicht, Managing Director of Proaut Technology GmbH. "The 'mini' size of the Gold Whistle servo drive is very beneficial to our latest technology machines."

Gold Whistle drives feature onboard intelligence. This supports built-in safety functionality such as safe torque off (STO, SIL-3, IEC 61800-5-2). STO enables the drive to remain energized while removing torque from the axis. The combination speeds up restart while ensuring the safety of operators, equipment, and product. Finally, the Elmo Application Studio (EAS) provides a unified software environment for servo drives and motors, making it easy to adapt the system to changes in product or process.

With ultra-fast settling times enabled by gain-scheduling technology, **Elmo's Gold Whistle drives enabled Proaut to increase the throughput of its latest-generation semiconductor test platform by 30%.** The compact form factor and 99% efficiency drives support a high-reliability solution in a compact form factor. The Proaut engineering team appears to be well satisfied with the performance. "The servo controllers of Elmo Motion Control fully meet all the criteria for our application," says Mr. Walsh. "They are ruggedly constructed and predestined for use in our precision measurement machines."

Contact Elmo to discover what our high-performance servo drives can do for your next project.

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