

Drive & Control profile

Bosch Rexroth Helps Semiconductor Equipment Company Lower Costs, Simplify Purchasing

Semiconductor manufacturing is probably the most exact manufacturing activity in the world. Companies are using expensive, precise machinery to produce semiconductor wafers whose features will soon be measured down to the thickness of atoms.

The latest generation of processing equipment uses silicon wafers 300 mm in diameter and achieves line widths as narrow as only 65 nm. Hundreds of finished electronic chips can be produced from a single wafer.

Wafer handling during the front-end of the manufacturing procedure is highly automated, with the wafer moving from station to station for each stage in the process. Robots pick up individual wafers for processing and move them between process chambers.

One trend that Bosch Rexroth has recognized throughout the industry is the shift of semiconductor equipment builders becoming more like



A wafer lift sub-assembly is about 24 inches high and uses a Bosch Rexroth servo drive and motor, Ball Rail® and ball screw.

system integrators rather than manufacturers. Instead of focusing on the material-handling aspects of the machine (called a “tool”), for example, the OEMs want to concentrate on core process improvements that differentiate their products and give them a market advantage. Rather than committing design resources on the material-handling

Challenge

Replace an in-house wafer-lift design with a lower-cost, ready-to-install subassembly

Bosch Rexroth Solution

A custom subassembly using Rexroth linear actuator, precision ball screw, servo drive, maintenance-free servo motor

Benefits

- Smooth, vibration-free motion
- 7+ million cycles
- Lower cost
- Streamlined supply chain
- Simplified procurement/inventory
- Ready to install

components, they are content on outsourcing these items to suppliers who can design and build subassemblies more efficiently. This represents a significant change in the supply chain as suppliers like Bosch Rexroth become collaborators and partners, applying their specialized expertise in helping OEMs build next generations of equipment.

The manufacturing of an automated wafer-lift subassembly is an example of this trend. A wafer lift measures roughly 10 x 12 x 24 inches high, weighs about 20 pounds, and consists of components including a linear actuator, wafer platform, motor, and support and mounting hardware. It is used in transferring wafers between robots. Wafer lifts are used in the load lock that serves as a transition between atmospheric conditions and a vacuum. They are also used internally by the robot that moves wafers between chambers inside wafer processing equipment.

Bosch Rexroth recently helped a major manufacturer of semiconductor processing equipment to simplify the design and construction of a new wafer lift assembly as part of that company's move from manufacturer to integrator.

The company had been purchasing about 30 separate components from a handful of vendors and was building the lift assembly in-house. While the existing design worked well, the OEM wanted to lower the cost of the assembly, streamline the supply chain by



The compact Bosch Rexroth EcoDrive Cs servo drive controls a 100-watt Rexroth MSM maintenance-free servo motor.

obtaining the wafer lift assembly as a single part number, and reduce engineering expenses in designing a new lift. In short, they were receptive to outsourcing the design and manufacturing to Bosch Rexroth, who had the expertise to provide a better lift assembly.

Before OEMs change a component design for cost-saving reasons, they want to be sure the savings are significant enough to warrant the change. Joel Galliher, semiconductor industry manager at Bosch Rexroth, says that OEMs in the semiconductor industry typically target savings of 20 to 30 percent before it becomes economical to justify the commitment of engineering resources. In this case, the OEM was interested in a new wafer lift assembly that would offer considerable savings—both in material costs and in-house resources.

Thus came the opportunity for Bosch Rexroth: design a lower-cost lift assembly and supply it as a single component ready to

install. The lift is an item requiring smooth motion control—a central expertise of Bosch Rexroth. The company began providing that expertise to the semiconductor market only in recent years. But as companies outsource designs to suppliers, the fit was natural. One advantage Bosch Rexroth offers is the application of cross-technology expertise in linear motion, servo control, and pneumatics for high-precision, high-value motion control.

According to Galliher, “The key parameters in this assembly were smooth motion and reliability over a lifetime that exceeds seven million cycles—all at a lower cost. The stiffness of our linear actuator was critical to providing a smooth, vibration-free movement to protect the unfinished wafer from damage. What’s more, our assembly achieves those seven million cycles without requiring field lubrication.”

Rexroth engineers devised a custom electromechanical solution using their size 15 Ball Rail® driven by a precision Rexroth 12-mm-diameter ball screw in the T5 accuracy class. A compact EcoDrive Cs servo drive, mounted remotely on the tool, controls the 100-watt MSM maintenance-free servo motor that powers the lift. The EcoDrive uses a fieldbus interface for intra-tool communications. The lift's stroke is 2.25 inches, the speed is 2.25 inches per second, and the cycle time is one cycle per second. The duty cycle is relatively low at one cycle every two minutes.

The lift handles a load of 12 pounds mass and a vacuum load of 108 pounds. The lift is in an atmospheric environment but is mechanically coupled to the hoop holding the wafer inside a vacuum chamber. Vacuum load is determined by the orifice diameter that the lift coupling shaft penetrates and “pulls” constantly against the lift. In addition, the bellows, which isolate the atmospheric environment from the vacuum environment, present an additional load of 20.9 pounds per inch as it compresses.

These performance specifications are respectable, but what is remarkable is the smooth motion—vibration-free for all practical purposes—that delivers high-value wafers for processing at a lower cost over the previous approach. To achieve optimum smoothness, Rexroth engineers calculated the proper balance of preload on the ball screw and alignment of the parts to achieve the best level of stiffness. If the stiffness is too loose, there is too much “slop” in the system, which allows vibration. Too much stiffness, on the other hand, allows small vibrations to propagate and resonate. In either case, smooth motion is degraded.

In addition, Rexroth supplies each assembled and tested lift



Rexroth engineers devised a custom electromechanical solution using their size 15 Ball Rail® driven by a precision Rexroth 12 mm ball screw in the T5 accuracy class to achieve the stiffness critical to smooth, vibration-free movement.

mechanism ready for installation—while meeting the cost-saving objectives over the previous design. And the OEM has only one part number to purchase: the wafer lift assembly by Rexroth.

As Galliher notes, “The new supply chain model is a win-win for both customer and supplier. We use our motion-control expertise to supply an assembly that performs better at a lower cost. Our customer simplifies the supply chain, reduces the in-house engineering and assembly costs, and can concentrate on differentiating high-value products for its customers.”

In the semiconductor manufacturing industry Bosch Rexroth offers drive, motion, and control products for

front- and back-end equipment, interbay automated material-handling systems, and support equipment—covering electronic drives and controls, linear motion, and pneumatics. Our servo motors, drives, and controls, HMIs, and I/O systems allow precise multiaxis controls. Linear motion Ball Rail® systems cover the range of speeds, precision, and load capacity and include cleanroom-certified systems. A pneumatics line, beyond miniature and standard valves and cylinders, includes non-contact transfer units, rotary indexers, wafer-handling frames, and grippers. Beyond our drive and control products, we provide cleanroom-certified structural aluminum framing that allows fast configuration of everything from workstations to work cells.

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