DESIGN NEWS

SEMICONDUCTOR MANUFACTURING

Design leads to more precise positioning

The semiconductor manufacturing process achieves its tremendous productivity gains by putting ever-smaller solid-state geometries on ever-larger silicon wafers. Sub-micron (130 to 180 nm) features are routinely used in VLSI (Very Large Scale Integration) silicon chips on a wafer as large as 300 mm (300,000 microns). Aerotech Inc. (Pittsburgh, PA), a supplier of translation stages for the semiconductor industry since the 1970's, has taken another step toward miniaturizing the process while maximizing resolution engineers can achieve.

Non-contact yet direct drive may seem to engineers to be a contradiction in terms. But Al Ciez, division manager, Aerotech Positioning Systems Div. (Pittsburgh, PA), says that Aerotech's Nano-Translator (ANT) stages use a specially designed electromagnetic motor array to achieve high-precision positioning important in some applications (10 nm for linear, 2 nm for vertical, and 0.027 arc-sec rotary). Adding 32-MHz circuitry enables these ANTs to move at speeds of up to 250 mm/sec. That's a lot of 10 nm increments per second to provide stable positioning.

Ciez says, "The motive force is unique at this time, especially considering the total travel of 25 mm (50 mm on some models) in a compact package of 100 x 90 x 33 mm. Most linear motors that you find on the market today are about that size."

Aerotech has long had a presence in the semiconductor-manufacturing arena. The company combined its expertise in manufacturing stages with its experience in motion control circuitry, motor design, and power supplies to develop a new compact design.

Key elements included miniaturized construction, orientation, and integration of a linear array of magnets into the stage body, along with an optimized magnetic circuit design to achieve high performance in a compact size. The direct-drive motor design couples with non-contact position feedback through encoders to deliver higher accuracies, resolution, and reliability at faster travel speeds than other offerings in these miniature sizes, he says.

The design addresses the limitations of mechanical drives, such as ball screws, when it comes to delivering constant speed and precise positioning. The ANT stages allow users to configure the various types of stages so that they provide up to six degrees of freedom of movement, Ciez says.

Developing the concept and final design of the "ANTs" resulted from conversations with key customers. Once the concept took form, the company unleashed its designers and engineers to work together. Mechanical, motor, power electronics, and servo-control disciplines combined to develop ideas and have them challenged by the others' ideas. Refinement came from communication among the group of representatives of those technologies.

ANT series miniature stages combine an integrated linear motor design with control electronics and power to form a new concept in precision motion control.

Aerotech manager Ciez says, "Our ANT series has already found wide acceptance in photonics assembly. The next step is to develop the appropriate form factor for the semiconductor industry, such as wafer articulation axes, to perform fine positioning of a wafer over a short distance."

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