DynamYX® RS Reticle Positioning Stage

The DynamYX RS Reticle Positioning Stage is designed for reticle inspection and repair applications. It features and extremely rigid ceramic reticle holder that is mounted to a single plane air bearing carriage. The cantilevered substrate is located away from all moving elements of the stage, which ensures the cleanest possible environment. The DynamYX RS Reticle Positioning Stage also has a full-open-aperture that accommodates flexible optical component integration as well as ease of service access. The footprint of this architecture is much smaller than traditional open-frame solutions.

DynamYX® Family of Air-bearing Stages

With the launch of the 300mm wafer initiative more than a decade ago, DynamYX was designed to provide equipment manufacturers in the semiconductor industry with a tool capable of achieving the highest levels of precision and throughput. DynamYX provides high resolution dynamic positioning of a wafer chuck or other similar substrate in two orthogonal translation axes from a single-plane carriage. A Vertical (Z) axis with Tip Tilt function and a rotary axis for wafer offset correction may be added on the carriage beneath the wafer chuck. Over the years, the form and function of DynamYX has evolved to keep pace with customer requirements. Today The DynamYX family consists of four specific designs each with their own specific features and benefits.

Position Feedback

The positioning loop on DynamYX may be closed using a single linear encoder for each axis. As shown in the adjacent illustration, the encoder measuring positions are closely located to the substrate's surface reducing the already minimal abbey offset affect. For the X-axis, the linear scale is typically mounted to the underside of the bridge structure with the read-head in-line with the system's optical path and affixed to the moving ceramic guide. System architectures that do not allow this configuration can be accommodated by mounting the X-axis scale to a supplementary SiC spar located at the rear side of the system. The Y-axis has its scale mounted to a small SiC bracket on the moving carriage. The read head is fixed to the arm of the L-shape structure. Read-heads which have fixed positions relative to the tool's optical path are beneficial in optimizing precision. With an encoder signal period of 2mm, resolutions down to 0.1nm are possible with Newport's XPS or SPS controllers each with internal 20,000 times interpolation.
Equipped with linear encoders the DynamYX is an extremely accurate and very repeatable platform allowing for very high accuracy through error mapping. The geometric stability of the ceramic elements of these stages results in systems that can be mapped once at our factory then, upon installation, only require a simple length calibration to compensate for uniform thermal expansion. For applications where the accuracy requirements exceed the capabilities of error compensation, or in certain scanning modes where the absolute position of the stage must be the basis of a very precise trigger or latch, linear encoders must yield to laser interferometers which are also part of our offering.

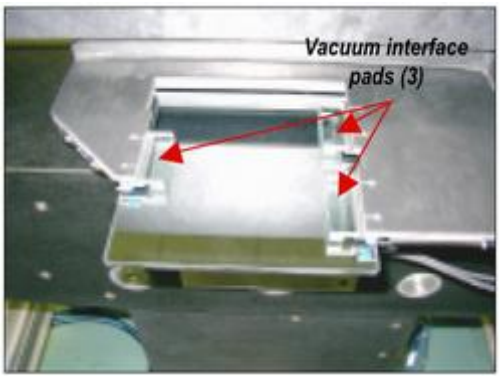
Chuck Interface

The standard mounting interface includes three precision-lapped pads for the direct mounting of a wafer chuck. In the DynamYX 300 and GT stages, these three pads are only 66mm above the granite reference plane maintaining the low-profile nature of the stage. Even with the addition of other accessory components such as a 4-axis Z-Tip-Tilt-Theta stage the height of the wafer plane in the DynamYX GT stage is only 115mm above the granite reference surface. The low profile nature of DynamYX contributes to the system's overall dynamic performance and attenuates the already minimal abbe offset effect of pitch and roll. If Newport is to supply the wafer chuck, the chuck (ideally ceramic), including vacuum lines to the chuck, and wafer lift pins may be supplied as an integrated solution.

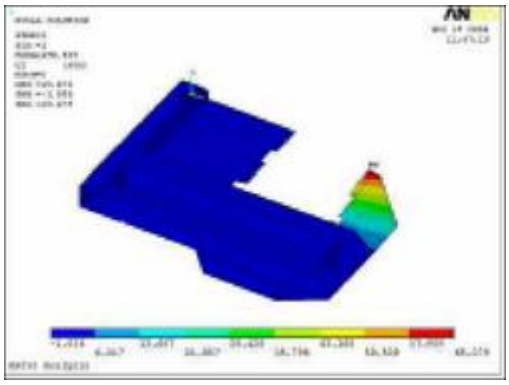
Linear Motor Drives

The original DynamYX 300 and DynamYX RS "Reticle Stage" tables are driven by only two Ironless linear motors; one in the X-axis and one for the Y-axis. The rating of each motor is carefully considered based on the intended duty cycle/throughput requirements as to minimize the power dissipation of the system. For even higher throughput requirements, the DynamYX GT and all-new DynamYX Datum incorporate a second X axis linear motor which is driven in open loop mode. Unlike H-bridge air bearing designs which rely on a synchronized servo loop for positioning and stiffness, the monolithic ceramic guide found in all four designs defines the positioning reference and overall stiffness of the positioning elements. Controlling any of the four DynamYX stages is very much like controlling a conventional XY stack with one control signal for X and one for Y. For the GT and Datum stages, a single X-axis control signal is split and fed into two amplifier channels where the output force is biased according to the linear motor ratings and total payload.
Most linear motors on the market were designed without focusing on the real needs of precision motion control applications where mass limits and efficiency are most critical. Newport air bearing stages benefit from our commitment to providing the highest possible performance by incorporating motors developed in-house that are optimized for the products and applications they address. Newport's linear motors have outstanding performance in the areas heat dissipation, time constant, force ripple, and structural integrity. From an efficiency standpoint, the performance of our motors is measured as the steepness per given motor volume where steepness is defined at the heat dissipated by a motor when delivering a given force (F2/W) and volume is simply the motor cross-section multiplied by the coil length. In situations where the rms acceleration values are extremely high and any heat loss is a problem, our motors feature sealed-forced air or recirculating water methods of cooling.

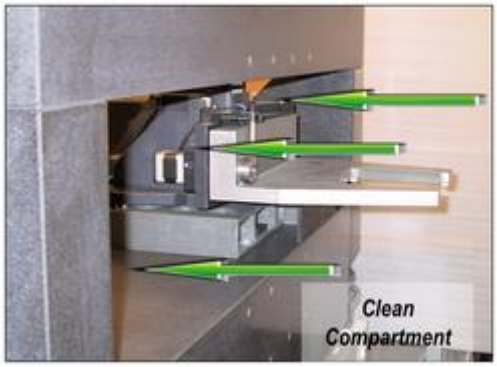
DynamYX RS is based on the same single plane architecture found in the DynamYX 300 & GT stages



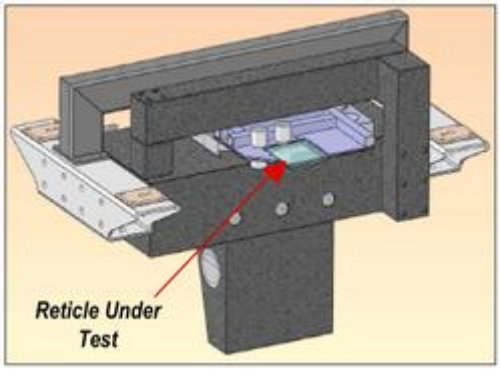
The ceramic reticle holder of the RS stage provides a vacuum-secured 3-point mask interface which is ESD safe. This mounting plane has a very tight parallelism tolerance with respect to the axes of travel.



FEA of the cantilevered Silicon Carbide reticle holder was used to secure stiffness and stability of the design (the RS reticle holder has a higher natural frequency in the vertical axis than the substrate is supports)



Reticle and Optics are located away from all moving stage elements where air flow prevents particles from entering clean compartment



The "Full-Open-Aperture" design provides unobstructed access to the front of the stage system and a completely open pallet for integration of optical assemblies

Design Details	DynamYX RS (Reticle Stage)
Stage Architecture	Full-Open-Aperture with Cantilevered Reticle Holder Supported by Single Plane XY Air Bearing, L-Shape Configuration
Material	Ceramic (SiC), Granite
Drive Mechanism	Brushless linear servo motors (one motor each for X and Y)
Position Feedback	Non-contact optical linear encoders - Heidenhain LIF, glass scale with 4 µm signal period
Bearings	Integrated Pressure-Vacuum Air Bearing
Cable Management	Fully integrated, clean-room compatible, single point exit/entry, mimimal external force

General Specifications	
Travel Range	290 mm X-axis 155 mm Y-axis
Footprint (without bridge pillars, standard travel)	950 mm x 800 mm
Rated Payload (mass of reticle and frame)	0.4 kg
Maximum Velocity (rated payload)	250 mm/sec X-axis 250 mm/sec Y-axis
Peak Acceleration (rated payload)	0.25 G X-axis 0.25 G Y-axis
RMS Acceleration (rated payload)	0.1 G X-axis 0.1 G Y-axis
Total Weight	500 kg
Stiffness, First Natural Frequency (stage)	150 Hz
Stiffness, First Natural Frequency (reticle holder)	400 Hz
MTBF	20,000 hrs.

Performance Specifications (note: all values given at level of Reticle)	
Pitch, Yaw, Roll (150 mm by 150 mm travel)	<10 µrad
XY Straightness & Flatness (150 mm by 150 mm travel)	0.5 µm TIR
XY Straightness & Flatness (25 mm by 25 mm travel)	0.1 µm TIR
XYZ Position Stability (on-air)	±10 nm
XYZ Position Stability (clamped)	±1 nm
XY Orthogonality	< 5 µrad
Speed Stability (velocity ripple sampled at 2kHz and 200mm/sec)	0.1%
XY Accuracy with Glass Scale, TIR, XY error compensation, 0.1 degree C temperature stability (150x150 mm2)	0.5 µm
XY Accuracy after clamping, TIR, XY clamping error compensation, 0.1 degree C temperature stability (150x150 mm2)	1 µm
XY Bi-Directional Repeatability on air	±25 nm
XY Bi-Directional Repeatability after clamping	±50nm
Step-and-Settle Times (using ND40 Passive Isolators)	Settling into ±0.1 µm window
100 mm step	< 600 msec X-axis < 600 msec Y-axis
25 mm step	< 350 msec X-axis < 300 msec Y-axis
25 mm step with clamping	< 550 msec X-axis < 500 msec Y-axis
Ideal Interpolated Encoder Resolution	2 nm