

# Planar<sub>HDX</sub> Series

## Two Axis, Silicon Carbide, Planar Air-Bearing Stage

Advanced silicon-carbide structure for high-dynamics and ultra-precise motion performance

Speeds to 1.5 m/s and accelerations to 5 g

Proprietary reaction-mass design enables fast turnaround and move-and-settle times

Active and passive isolation system options

Encoder or laser interferometer feedback

Linear motors with improved thermal management

Advanced control solutions offer enhanced throughput



*Planar<sub>HDX</sub> provides the highest possible dynamic performance while maintaining unparalleled geometric characteristics and positioning accuracy.*

a new air-bearing compensation strategy that increases stiffness and load capacity for demanding high-dynamic applications. Using proven air-on-air preloading in critical bearing elements improves turnaround and settling times over vacuum-preloaded designs.

A proprietary reaction-mass design dramatically reduces stage-induced forces in the step-axis that are transferred to the isolation system or customer's structure (optics, sensors, etc.). By minimizing these dynamic forces, move-and-settle time is reduced and process throughput is increased.

Depending on the application requirements, the Planar<sub>HDX</sub> is available with passive or active isolation systems. Additional axes such as Z-tip-tilt or Z-theta designs as well as custom wafer load/unload mechanisms and wafer chucks are available. Machine weldments, complex granite base structures or enclosures can also be provided.

Aerotech's long history of supplying ultra-precise positioning systems in high-technology fields such as semiconductor manufacturing has enabled ongoing development and improvement of key motion technologies. By building upon these technologies, Aerotech has developed the Planar<sub>HDX</sub>, the most advanced commercially available planar air-bearing platform on the market. Designed using an FEA-optimized silicon carbide structure and optimized air-bearing compensation techniques, the Planar<sub>HDX</sub> provides the highest possible dynamic performance while maintaining unparalleled geometric characteristics and positioning accuracy.

### Ultra-Precise Design

Planar<sub>HDX</sub> structural elements have been designed using an advanced silicon carbide ceramic that has a specific stiffness (elastic modulus/density) five times higher than aluminum and a coefficient of thermal expansion approximately five times lower. The resulting material along with an FEA-optimized structure enables high-throughput motion (1.5 m/s scan speeds and 5 g peak acceleration with a payload up to 20 kg) without sacrificing dynamic tracking, geometric performance, or thermal stability.

Using nearly 50 years of experience in air bearing and precision motion system design, Aerotech has developed

### High Accuracy Feedback

As a standard offering, the Planar<sub>HDX</sub> is available with low-expansion glass scales on each axis. The scale and readhead locations are chosen to minimize Abbe and thermally-induced errors. For applications requiring the highest-levels of accuracy, Aerotech can provide laser interferometer feedback with mirrors located at the workpoint with integrated wafer chucks or workholding devices. In both encoder and interferometer feedback systems, the materials and mounting methods are optimized to provide high-dynamic operation while minimizing thermally-induced accuracy errors.

## Planar<sub>HDX</sub> DESCRIPTION

### Noncontact Direct-Drive Technology

At the heart of the Planar<sub>HDX</sub> are Aerotech's BLM and BLMH linear motors, which employ an ironlessforcer design for ultra-smooth motion. Both the step and scan axes use multiple motors driving near the center-of-mass to provide exceptional vertical/lateral straightness and minimal angular errors. The motors are thermally-isolated, and for high duty-cycle applications can be water cooled to minimize thermal errors caused by motor heating.

### Advanced Mechatronic Solution

Aerotech manufactures not only the mechanical elements, but also the electronics and control elements of the positioning system. In doing so, critical drive and software control features can be tightly coupled to the mechanics, providing not only a one-stop solution, but also enabling a complete mechatronic solution with unmatched performance. Many advanced control features such as directional gain scheduling, iterative learning control, and harmonic cancellation exist as a result of development for use in specific applications with Aerotech controls and mechanics.

Aerotech's ETM (Enhanced Throughput Module) option helps improve the positioning performance of high-dynamic motion systems like the Planar<sub>HDX</sub> by directly measuring the unwanted motion of the machine base and communicating it back to the controller. By working in concert with the Dynamic Controls Toolbox and Aerotech controllers, the ETM significantly improves move-and-settle time and contouring performance, increases throughput of existing and new machines, and greatly reduces the effects of frame motion on the servo system.

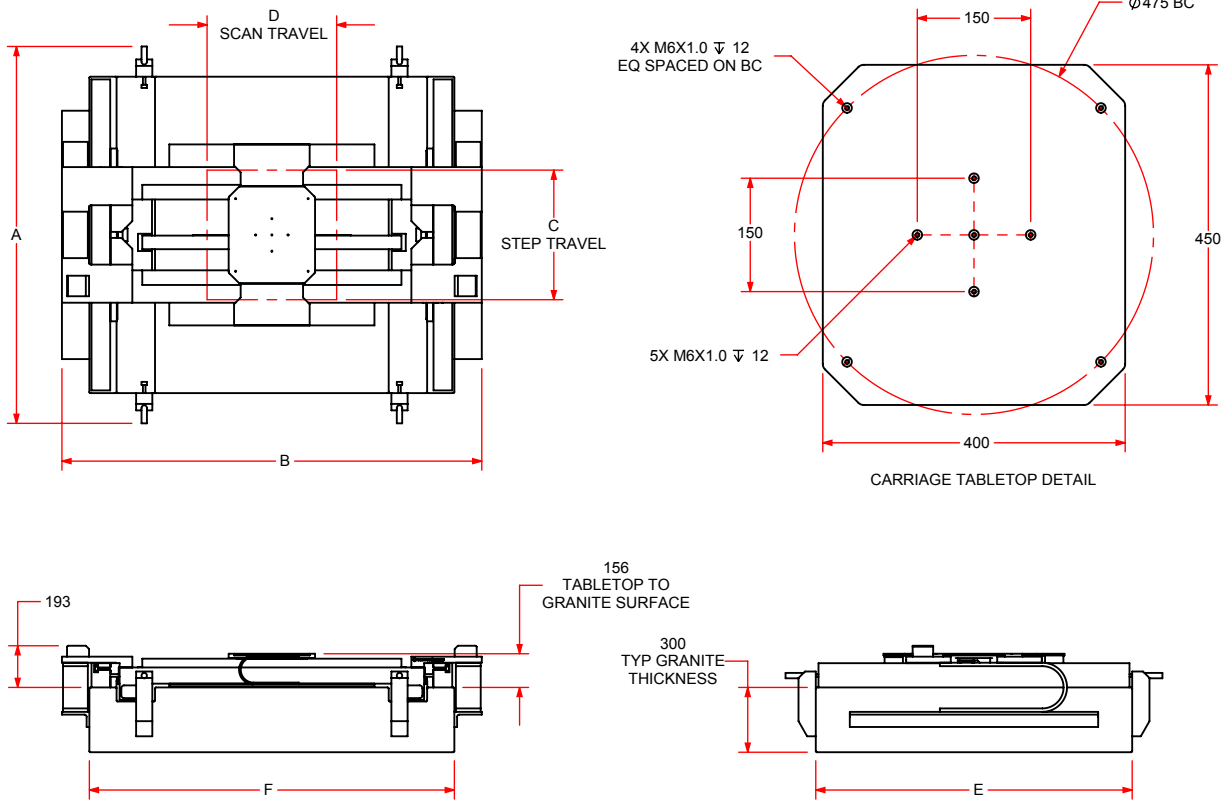
Mechanical Specifications		Planar <sub>HDX</sub> -450-450	Planar <sub>HDX</sub> -600-600	Planar <sub>HDX</sub> -750-750
Travel <sup>(1)</sup>		450 mm x 450 mm	600 mm x 600 mm	750 mm x 750 mm
XY Accuracy <sup>(2, 3)</sup>		±100 nm		
Bidirectional Repeatability <sup>(3)</sup>		±15 nm		
Straightness		200 nm per 450 mm		
Flatness		300 nm per 450 mm		
Pitch/Roll		10 µrad (2 arc sec) per 450 mm		
Yaw		5 µrad (1 arc sec) per 450 mm		
XY Orthogonality		<2 µrad (0.4 arc sec)		
Maximum Speed <sup>(4)</sup>	X Axis (Step)	1.0 m/s		
	Y Axis (Scan)	1.5 m/s		
Peak Acceleration <sup>(4)</sup> (With Rated Payload)	X Axis (Step)	3 g (29 m/s <sup>2</sup> )		
	Y Axis (Scan)	5 g (49 m/s <sup>2</sup> )		
RMS Acceleration <sup>(4)</sup> (With Rated Payload)	X Axis (Step)	1.1 g (10.8 m/s <sup>2</sup> )		
	Y Axis (Scan)	1.2 g (12.8 m/s <sup>2</sup> )		
Rated Payload (Maintaining Dynamic Specifications)		20 kg		
Maximum Payload <sup>(4,5)</sup>		40 kg		
In-Position Jitter (On Air) <sup>(6)</sup>		±2.5 nm (Z), ±5 nm (X and Y)		
Typical Step and Settle Times (With Rated Payload and Passive Isolation); Measured on a 750 mm x 600 mm System, ±100 nm Settle Window		25 mm step - X-axis: 150 ms; Y-axis: 115 ms		
		100 mm step - X-axis: 245 ms; Y-axis: 190 ms		
		300 mm step - X-axis: 450 ms; Y-axis: 380 ms		
System Operating Pressure <sup>(7)</sup>		550 kPa ±35 kPa		
Air Consumption <sup>(8)</sup>		130 SLPM		
Material		SiC Ceramic, Granite		
MTBF		>40,000 hrs		

Notes:

- Other custom travels available upon request.
- XY accuracy measured over 450 mm x 450 mm area. Specified for linear encoder options. Consult factory for laser interferometer feedback.
- Results highly dependent on environment and duty cycle. Temperature stability to <0.1°C required.
- Requires the selection of an appropriate amplifier with sufficient voltage and current.
- Maximum load may be limited by specifications required.
- In-position jitter reported as pk-pk. Highly dependent on the isolation system and environmental conditions.
- To protect the air bearing against low-pressure, an in-line pressure switch tied to the motion controller ESTOP input is recommended.
- Air supply must be clean, dry to -15°C dew point and filtered to 0.25 µm or better. Recommend Nitrogen at 99.9% purity.

Electrical Specifications	Planar <sub>HDX</sub>
Drive System	Brushless Linear Servomotors
Feedback	Glass/Zerodur™ Linear Encoders (Laser Interferometer Options Available)
Maximum Bus Voltage	340 VDC

Recommended Controller		Planar <sub>HDX</sub>
Multi-Axis	A3200	Npaq 6U Ndrive HLe Ndrive HPe



STAGE	A	B	C	D	E	F
PLANAR HDX-450-450	1625	1795	450	450	1345	1540
PLANAR HDX-600-600	1745	1945	600	600	1465	1690
PLANAR HDX-750-750	1895	2095	750	750	1615	1840

DIMENSIONS: MILLIMETERS

## Planar<sub>HDX</sub> ORDERING INFORMATION

### Planar<sub>HDX</sub>

Planar<sub>HDX</sub> The Planar<sub>HDX</sub> series is a two-axis, ultra-high performance, air-bearing stage manufactured from an advanced silicon carbide ceramic for high-dynamic and ultra-precision motion performance. Includes ceramic air-bearing stage with granite base and cable management.

### Stage and Travel

Planar <sub>HDX</sub> -450-450	Silicon-carbide, planar air-bearing; Planar <sub>HDX</sub> -450-450
Planar <sub>HDX</sub> -600-600	Silicon-carbide, planar air-bearing; Planar <sub>HDX</sub> -600-600
Planar <sub>HDX</sub> -750-750	Silicon-carbide, planar air-bearing; Planar <sub>HDX</sub> -750-750

### Feedback (Required)

-E1	Incremental glass encoder, 1 Vpp output
-E2	High-accuracy incremental glass encoder, 1 Vpp output
-E3	High-accuracy low-expansion incremental glass encoder, 1 Vpp output
-E4	High-accuracy/resolution low-expansion incremental glass encoder, 1 Vpp output
-E5	Laser interferometer feedback

### Reaction Mass (Optional)

-RM	Reaction-mass design, step axis
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### Motor Cooling (Optional)

-WC	Water cooling on all linear motors
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### Isolation System (Optional)

-ISO1	Active vibration isolation system
-ISO2	Passive vibration isolation system

### Cable Management (Optional)

-CMSxxxx	Cable management for customer air lines, auxilliary connectors, additional axes, etc. Contact factory for details.
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### Performance Grade (Required)

-PL4	Ultra-high accuracy 2D performance
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### Integration

Aerotech offers both standard and custom integration services to help you get your system fully operational as quickly as possible. The following standard integration options are available for this system. Please consult Aerotech if you are unsure what level of integration is required, or if you desire custom integration support with your system.

-TAS	<p><b>Integration - Test as system</b></p> <p>Testing, integration, and documentation of a group of components as a complete system that will be used together (ex: drive, controller, and stage). This includes parameter file generation, system tuning, and documentation of the system configuration.</p>
-TAC	<p><b>Integration - Test as components</b></p> <p>Testing and integration of individual items as discrete components that ship together. This is typically used for spare parts, replacement parts, or items that will not be used together. These components may or may not be part of a larger system.</p>