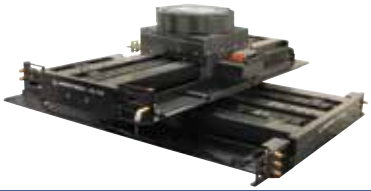
Motion and Automation for Test, Measurement, and Inspection

Surface Profiling

Semiconductor Inspection and Metrology



Sensor Testing

Cleanroom and High Vacuum Systems

Machine Automation

AEROTECH

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Capabilities in Test, Measurement, and Inspection

Since 1970, Aerotech has been dedicated to developing solutions for the test, measurement, and inspection industry. Our expertise includes systems for shop floor, R&D, vacuum, and cleanroom environments. Our ability to provide custom-engineered products and systems to end users, integrators, and high-volume OEMs is unmatched, and our products deliver quality, performance, flexibility, and the highest return on investment.

Sensor Testing 4

- Single- and multi-axis rate tables
- Motion simulator software
- Advanced control techniques
- Excellent rate and in-position stability

Surface Profiling 16

- Compact surface measurement platform (SMP)
- Linear amplifiers
- Integrated system support
- Measure wafers, optics, and cylindrical shapes
- Intuitive control electronics and software

Nondestructive Test 26

- X-ray inspection
- Ultrasonic testing
- Large selection of components
- Linear amplifiers
- Linear and rotary motors

Semiconductor Inspection and Metrology 32

- Ellipsometry, scanning white light interferometry, stylus measurements
- High-performance linear motor stages
- Low profile direct-drive vertical and rotary stages
- Vacuum chuck options with integrated leveling mechanisms
- Linear and PWM digital controllers

Vacuum and Cleanroom Systems 42

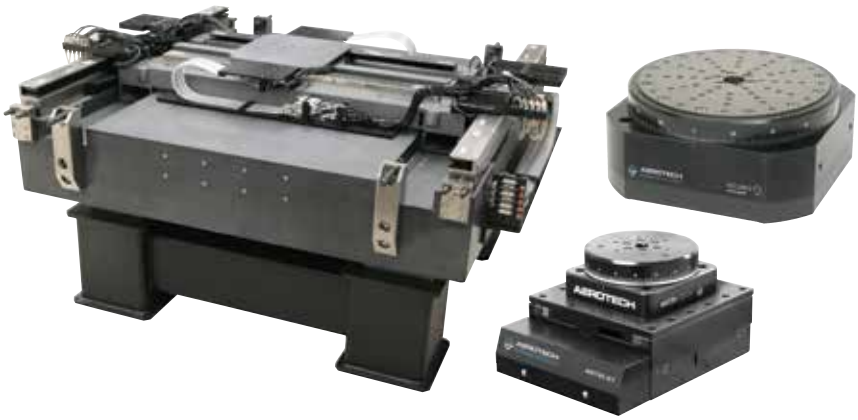
- Satellite inertial navigation system testing
- Scanning electron microscopy
- Optics polishing
- Vacuum options for 10^{-3} to $<10^{-7}$ Torr
- Experience with vacuum applications

Machine Automation 46

- Stand-alone and PC-based controllers
- PLC and motion integration with MotionPAC
- Operator interface
- Advanced tuning and controls features

Rotary and Linear Motion 53

- Rotary motion solutions
- Linear motion solutions
- Planar air-bearing solutions
- Nanopositioners



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Sensor Testing

Inertial Sensor Testing and Calibration

Rotary and linear motion simulator solutions

Applications

- Accelerometers
- Gyroscopes
- MEMS calibration
- Inertial measurement units

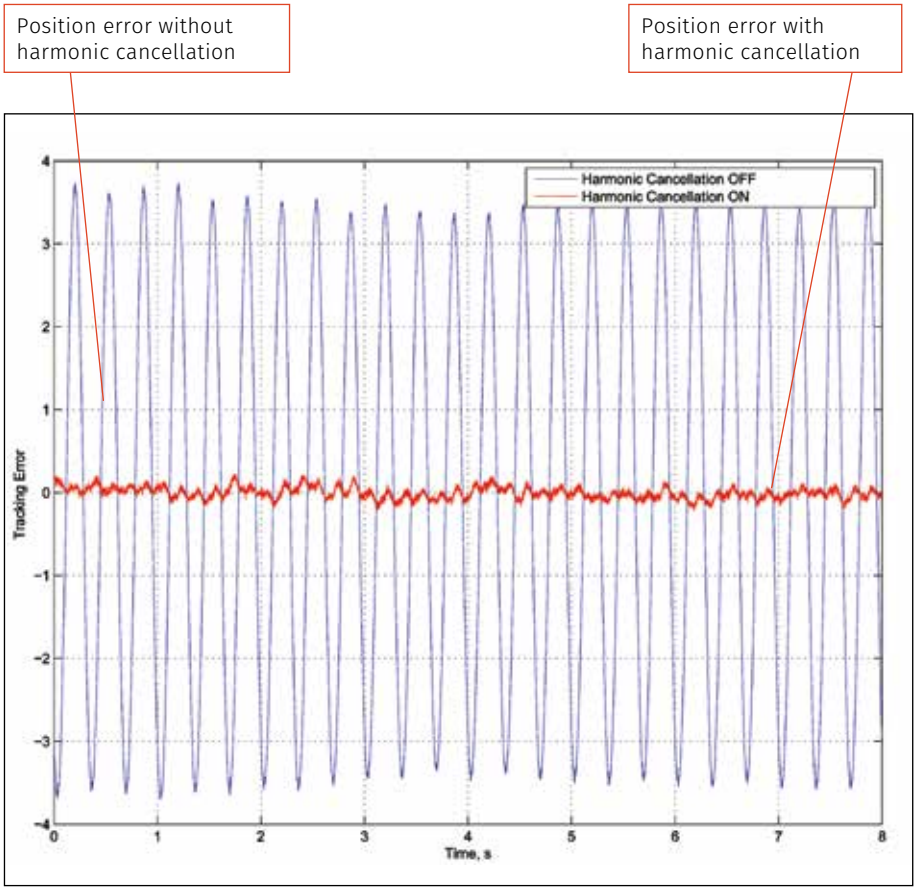
Aerotech has multiple solutions for the testing and calibration of inertial sensors. All are designed to induce sinusoidal excitations, accelerations, and positions for the testing and calibration of accelerometers, gyroscopes, inertial navigation systems, fiber optic gyros, and inertial measurement units. When coupled with our state-of-the-art controllers, highly-repeatable testing and calibration are assured.

Features and Benefits

- High accuracy, direct-drive motion simulators
- Mechanical or air bearings
- Real-time data collection
- Position, velocity, acceleration, and time oscillation modes
- Easy-to-use programming tools
- Slip-rings for user signals/power
- Single- and multi-axis systems

Inertial Sensor Testing and Calibration

Single-axis rate-table solutions



Advanced Control: Harmonic Cancellation dramatically minimizes oscillatory tracking errors

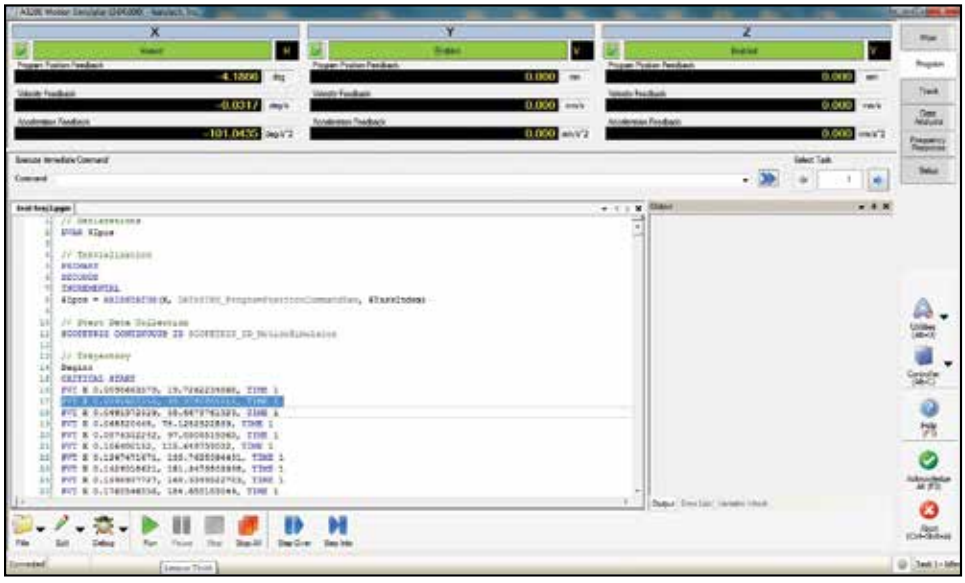
Precision Direct-Drive Rotary Position and Rate Tables

- High-capacity angular contact bearings or air bearings
- High-resolution position encoders
- Highly accurate closed-loop control
- Brushless, slotless motors for smooth motion with no cogging
- Large selection of integrated, low-noise slip rings for customer signals and power
- Multiple motor types for high speed or high-torque configurations
- Excellent error motion performance
- Dual liquid or gas ports/ rotary unions
- Low-maintenance design

Motion Simulator

User interface for 1, 2, or 3-axis motion simulators

Main screen provides manual control



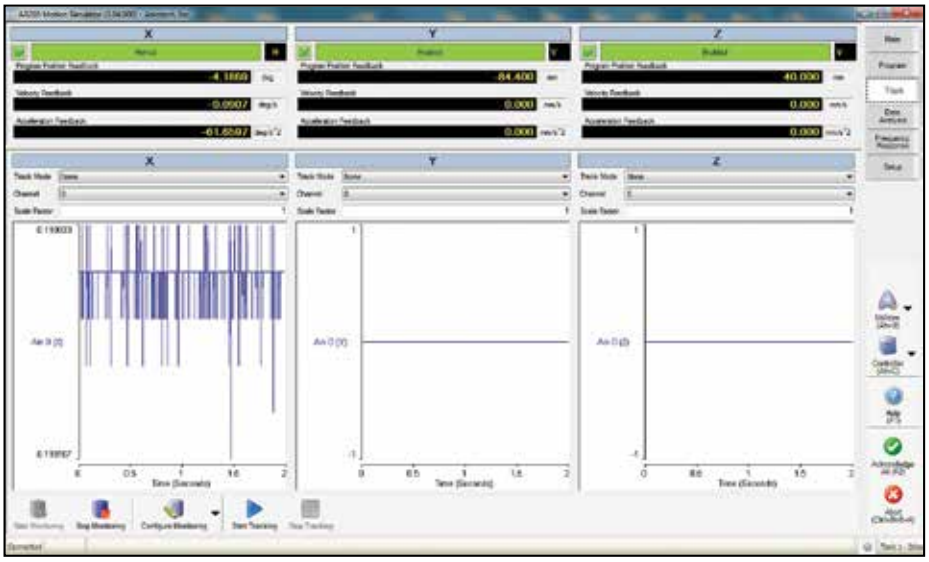
Program screen provides user programming environment

Motion Simulator is an easy-to-use Windows®-based program for creating simple and advanced motion stimuli for testing and calibrating inertial sensors and systems. The Aerotech Motion Simulator software includes all controls for manually or automatically running one to three-axis motion simulations.

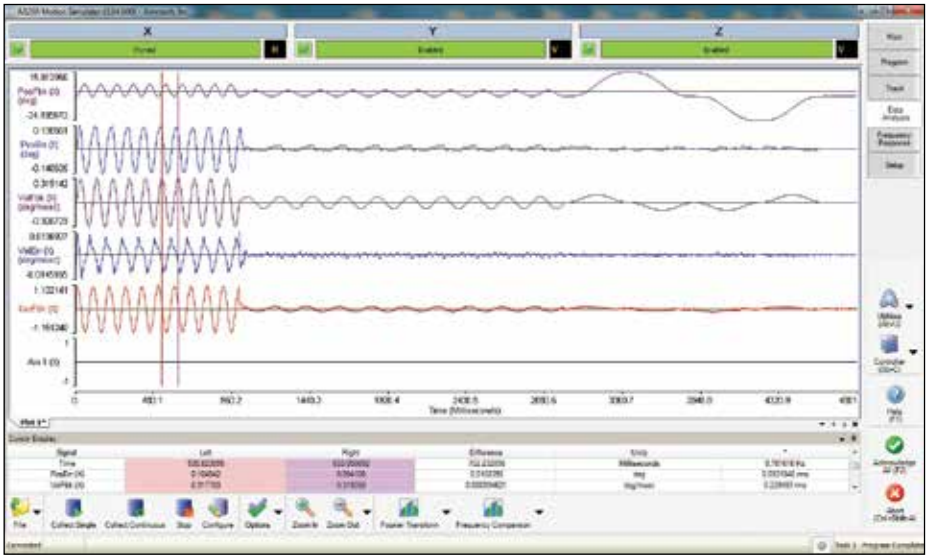
Features and Benefits

- Graphical motion profile importing (Position, Velocity, Acceleration, Time)
- Position Synchronized Output (PSO) for real-time event triggering
- Trajectory tracking from Ethernet, analog, or program inputs
- Iterative Learning Control minimizes position error
- Harmonic Cancellation optimizes motion position errors generated by sinusoidal motion

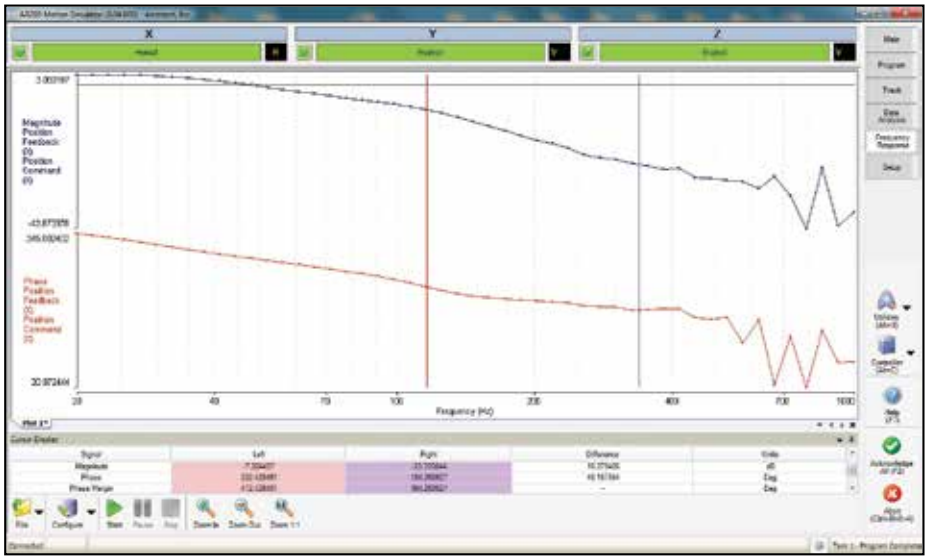
Motion Simulator



Track page provides real-time input controls for servo tracking of position or velocity inputs



Data analysis



Frequency response screen allows UUT frequency response testing

Track

- With the tracking functionality you can treat an analog input as either a position or velocity command, and track a signal from an external sensor or profile generation tool
- Available for each active axis
- Configurable sampling time

Data Analysis

- Extensive analysis tools are built-in and easily accessible through the Data Analysis tab
- Options for overlapping data by axis or signal
- Single or continuous data collection modes
- Frequency comparison function for comparing the measurement axis to a reference axis

Frequency Response

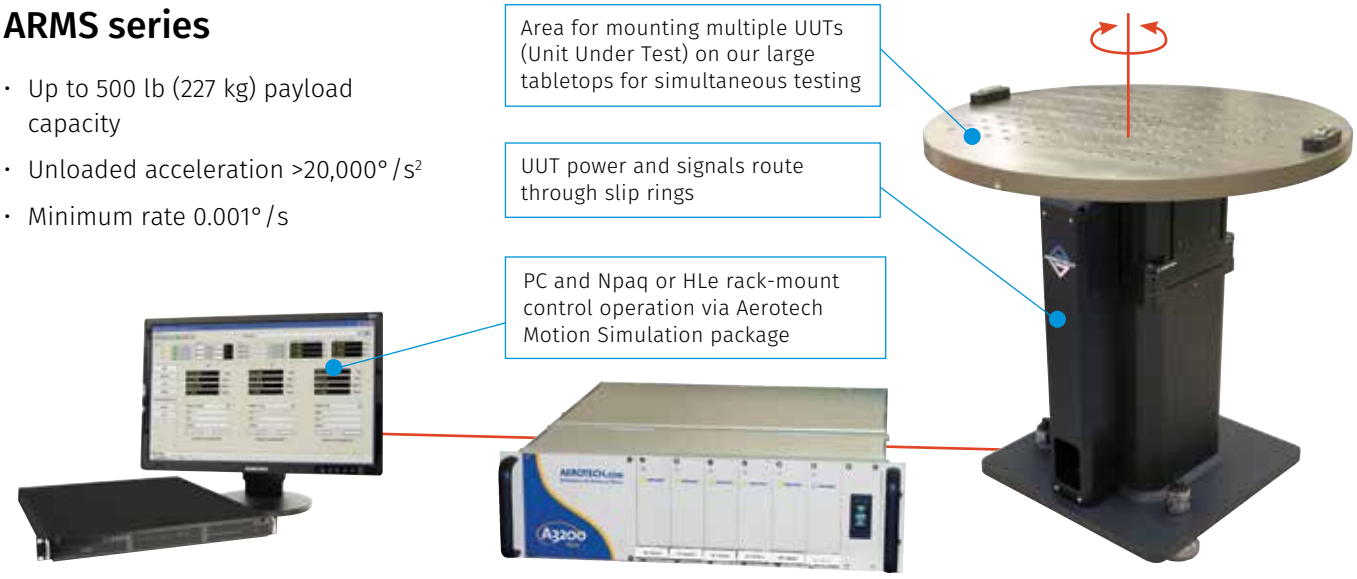
- Fully configurable excitation including sampling, start, and end frequencies and amplitude
- Provides both magnitude and phase plots
- Independent left and right cursors with dynamic summary table provide details on selected data
- Data can also be exported for further analysis

Motion Simulator

A variety of rotary configurations for sensor testing

ARMS series

- Up to 500 lb (227 kg) payload capacity
- Unloaded acceleration >20,000°/s²
- Minimum rate 0.001°/s



Single-Axis ARMS Series Rate Tables

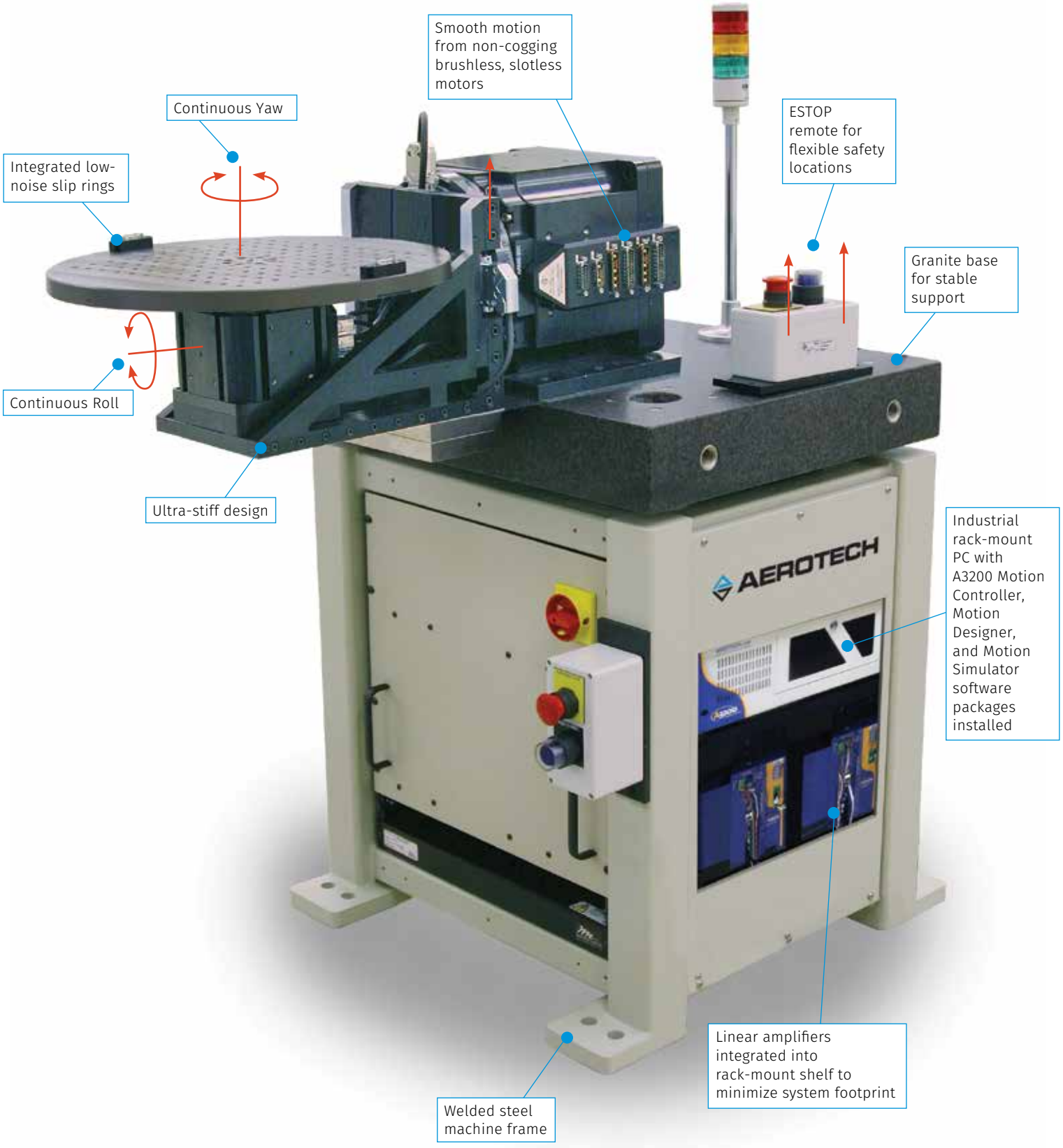
- Single-axis configurations include optional free standing, high stiffness pedestal with leveling feet
- Configurable for continuous or limited travel
- Custom slip-ring options available
- Vertical and horizontal orientation options
- Several tabletop diameters available

High-Accuracy Single-Axis Rate Table with Tilt Table

- Allows rate-table performance at multiple inclination angles
- Mounted to a gear-drive rotary table for tilt motion

Motion Simulator

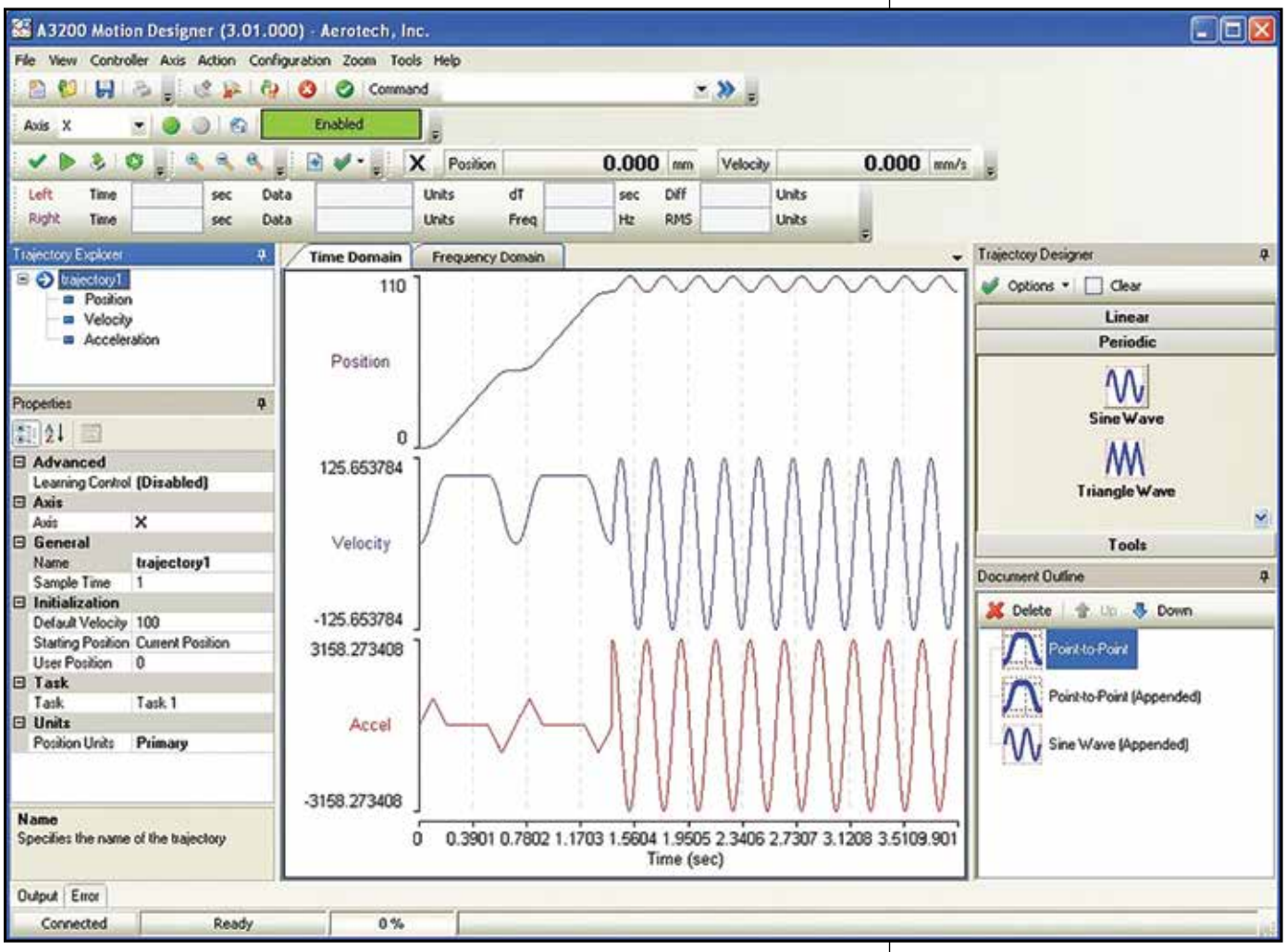
Two-axis rate table with integrated electronics



Motion Designer

Graphically design your motion profile – no coding required

Motion Designer is used to graphically generate and edit motion profiles and to import, run, and evaluate motion profiles (trajectories).



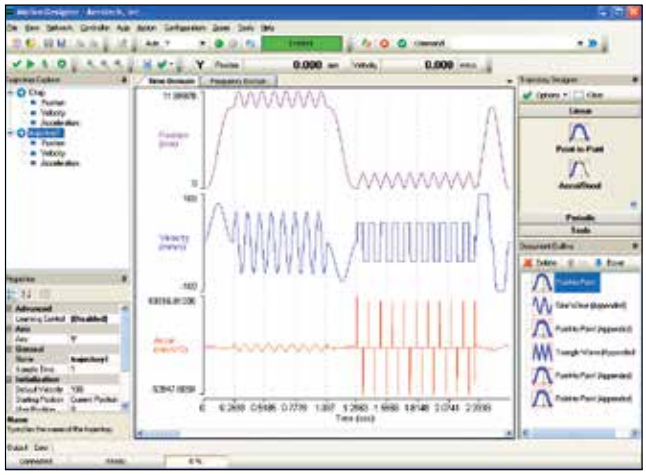
Motion Designer is used to graphically design your motion profile.

Features and Benefits

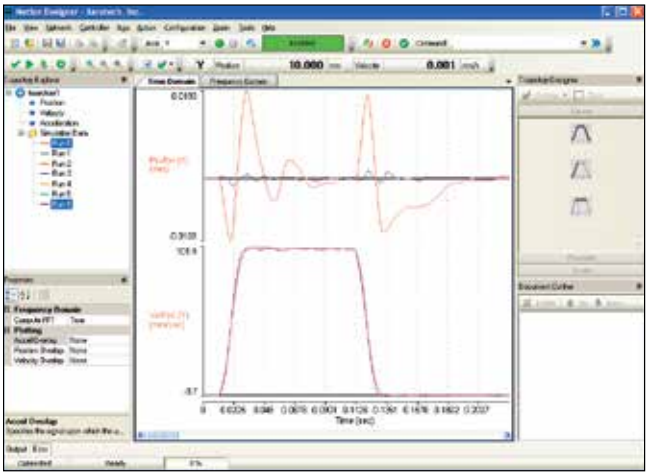
- Graphically create and modify multi-axis trajectories from predefined building blocks
- Run a trajectory, plot collected data, and use analysis tools
- Apply learning algorithms
- Export trajectory to an external file
- No need to write code
- Fast implementation

Motion Designer

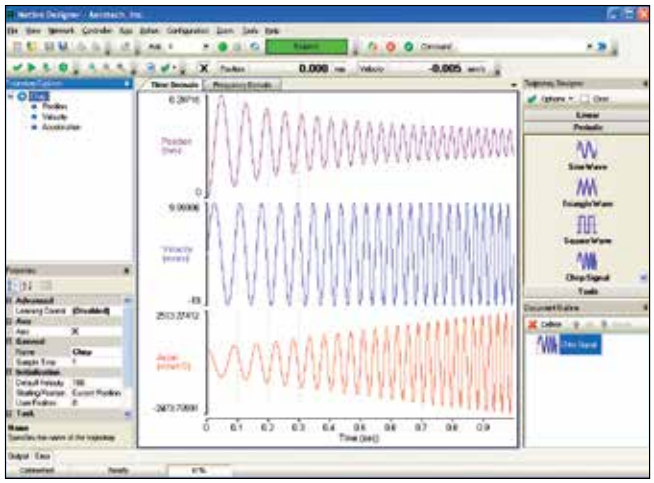
Fast and effecient trajectory generator



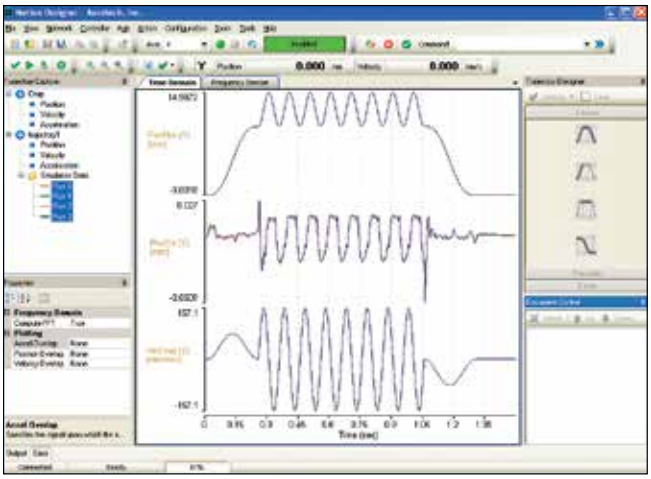
Create complex trajectories by combining linear and periodic motion profiles.



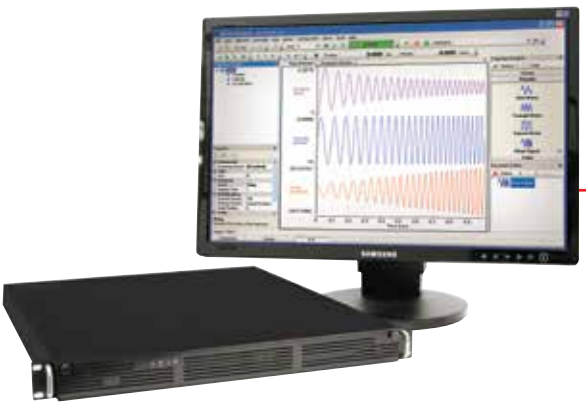
Iterative Learning Control reduces following error and cycle time, thereby increasing machine throughput.



Generate various pre-defined periodic waveforms.



Overlap data collected from multiple runs of a trajectory.



A3200 Automation Controller with Motion Designer add-on

Single-axis ARMS stage on mounting pedestal

General Sensor Testing

Stages and controls for general sensor testing

A3200 and Ensemble multi-axis motion controllers

APR precision rotary stage

ADRS direct-drive low-profile rotary stage

PRO165LM direct-drive linear stage

Sensors of all shapes and sizes can be found in virtually every product that is manufactured. Sensors allow the products we use to work smarter and safer. The testing of these devices is critical to ensure safe and accurate operation. Regardless of the sensor type, Aerotech has a solution to meet your testing needs.

Applications

- Position sensors
- Infrared detectors
- Automotive sensors
- Pressure sensors
- Radar sensors

Products

- APR
- ADRT/ADRS
- PRO-SL ball-screw and PRO-LM linear motor stages
- AGC goniometers
- ACT linear actuators
- AGS1500 gantries
- Custom solutions

Features and Benefits

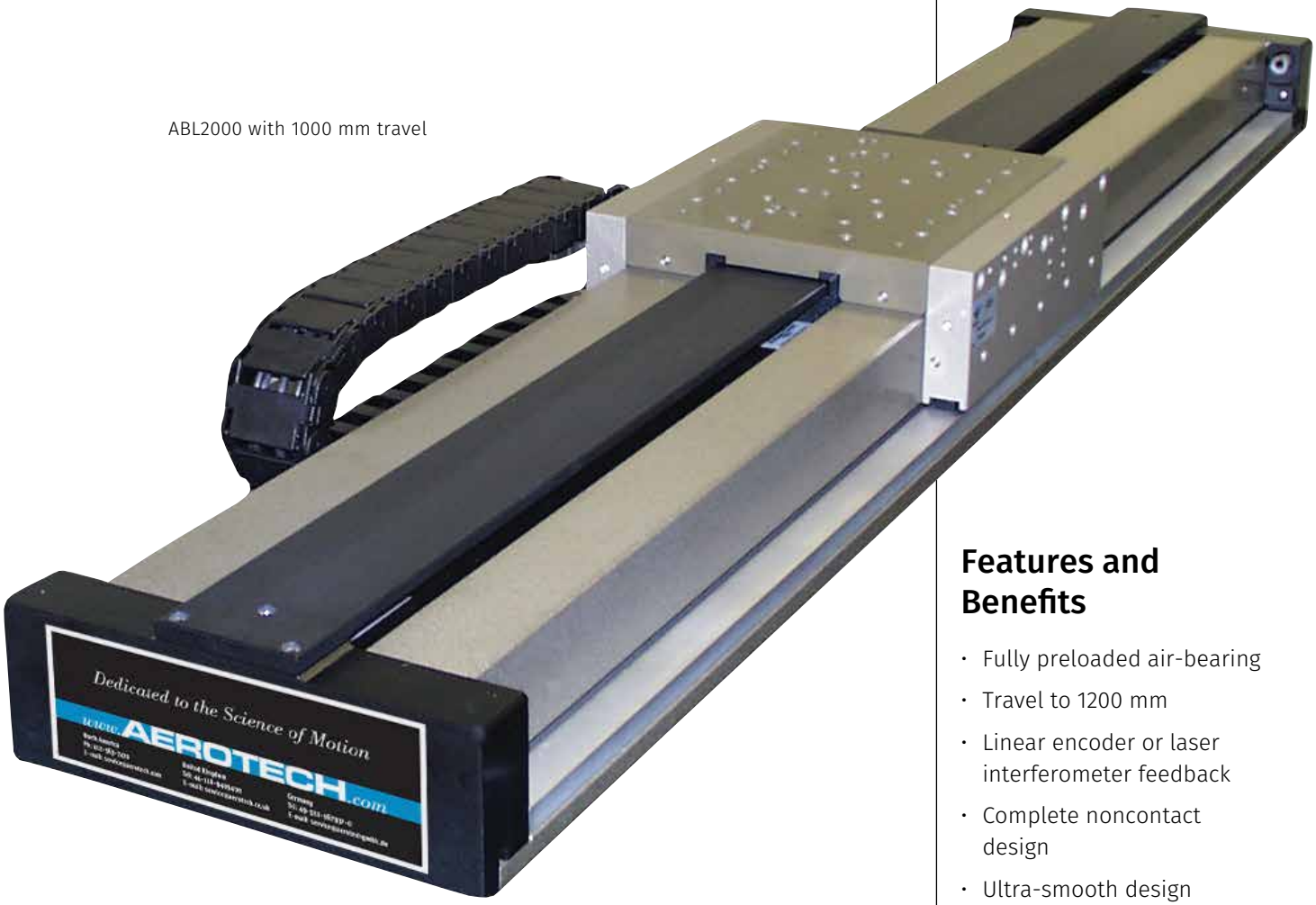
- Superior velocity stability
- Low settling time
- High throughput
- High accuracy
- Component level to turnkey system capabilities
- Numerous stage offerings
- Customizable user interface
- Advanced control techniques

General Sensor Testing

Testing solutions for position measurement devices

Linear position measurement devices require extremely accurate stages for calibration and verification of performance. Aerotech manufactures several single-axis air-bearing solutions that provide an excellent reference for measurement device qualification.

ABL2000 with 1000 mm travel



Features and Benefits

- Fully preloaded air-bearing
- Travel to 1200 mm
- Linear encoder or laser interferometer feedback
- Complete noncontact design
- Ultra-smooth design for outstanding velocity stability

General Sensor Testing

Testing solutions for the precise measurement of position, velocity, and acceleration

Azimuth over elevation

Elevation over azimuth

A3200 controller

Aerotech offers a multitude of precision rotation stages well-suited for testing and verifying a wide variety of measurement sensors and devices including position measurement devices. Aerotech can provide the exact configuration to meet your requirements – whether that is a single axis, a two-axis azimuth-over-elevation or elevation-over-azimuth configuration, or even a 3+ axis solution.

Features and Benefits

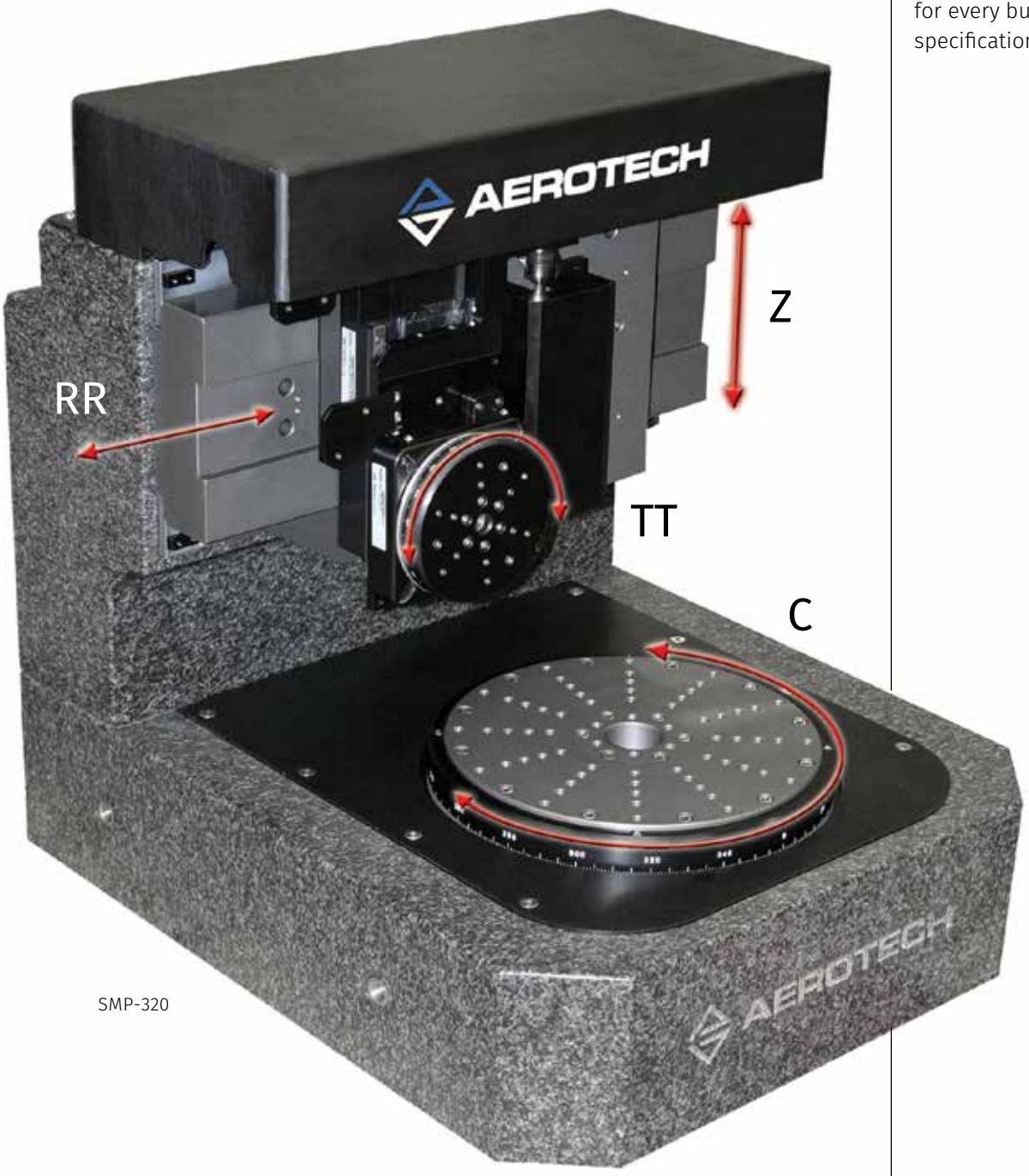
- Industry-leading performance in angular positioning and rate stability
- Direct-drive motor technology for smooth contoured motion with zero cogging
- Air-bearing technology greatly reduces unwanted error and significantly extends lifetime
- Record and track sensor signals through a variety of high-resolution analog and digital inputs
- Advanced control algorithms to increase throughput and improve motion performance

Surface Profiling

Surface Measurement Motion Platform (SMP)

Fully configured surface profiling stage system

A unique solution for surface profiling needs, the SMP is particularly effective when measuring or testing symmetric objects. With the small mechanical footprint, integrated controls, and flexible sensor integration, the SMP can be easily added to any testing facility or manufacturing line. With the compound stages available as air bearing or mechanical bearing, there is a solution for every budget and specification.



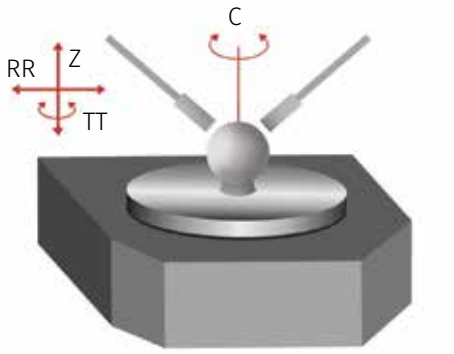
SMP-320

Surface Measurement Motion Platform (SMP)

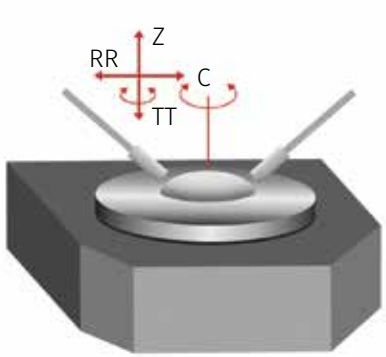
Fully configured surface profiling stage system (continued)

Features and Benefits

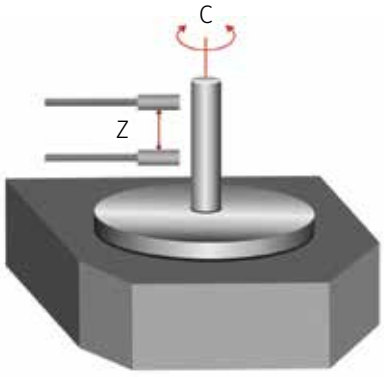
- Ideal for rotationally symmetric objects
- Configurable multi-axis design
- 60% smaller than traditional Cartesian systems
- 40% faster than traditional systems
- Mechanical or air-bearing options
- Flexibility to measure top and side surfaces as well as flat or spherical parts
- Easy sensor integration
- Nanometer-level position repeatability
- Versatile software architecture
- Advanced control techniques to eliminate environmental disturbances
- Custom configurations available



Spherical



Aspheric



Cylindrical

Surface Profiling and Measurement Solutions

Ultra-high performance, integrated 3-plate stage

Surface profiling applications present challenges to motion control technology on a number of fronts. Extremely high probe sensitivity is required for state-of-the-art systems, mandating the smallest possible parasitic error motion (such as flatness), while high-speed data collection must not be hindered by the automation controller. Aerotech's integrated scanning platforms offer key features to increase both throughput and performance.

The Planar$_{DL}$ is available in the following XY travels (mm): 100, 200, and 300

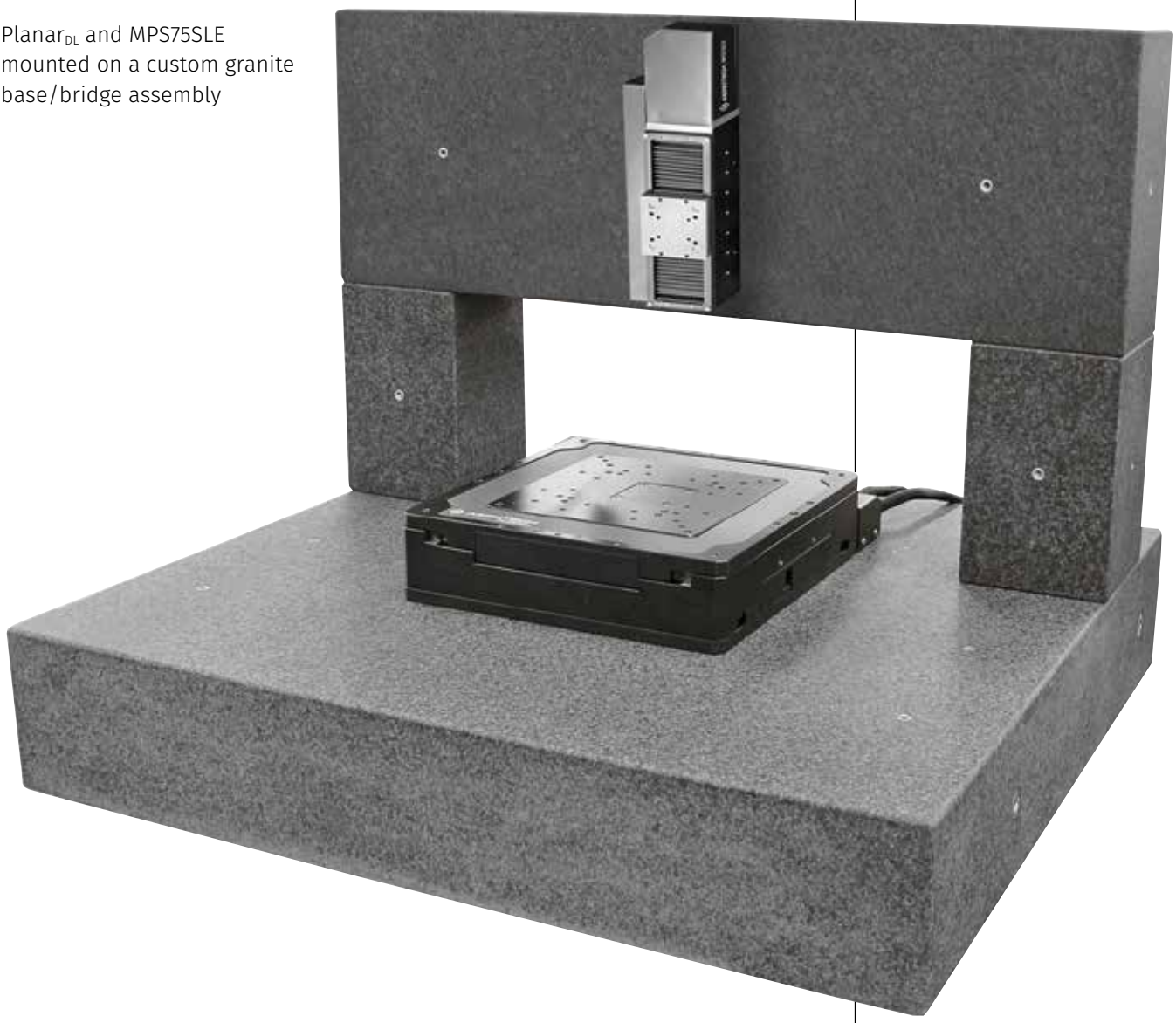
Features and Benefits

- Excellent geometric performance minimizes error motions
- Clean three-plate design
- Linear motor and screw-drive options
- Easy sensor integration
- Advanced control techniques to eliminate environmental disturbances
- Intuitive high-resolution analog inputs for data acquisition
- Custom configurations available

Surface Profiling and Measurement Solutions

Streamlined multi-axis configurations

Planar$_{DL}$ and MPS75SLE mounted on a custom granite base/bridge assembly



Surface Profiling and Measurement Solutions

Accurate sensor positioning Z-stage options

ANT130-L-ZS

- Optimized for high dynamics
- Dual counterbalance design eliminates error motions
- Nanometer performance easy to achieve with Aerotech controls

MPS75SLE

- Precision ball-screw
- Low CTE glass-mounted linear encoder
- Sub-micron positioning performance

Microscopy Solutions

Open-frame design for dual-sided access

Aerotech's Planar$_{DLA}$ series stages offer a clear aperture, high dynamics, and exceptional geometric performance in a compact, low-profile package. These stages are essential for applications ranging from two-sided LED wafer processing where high-dynamics and micrometer-level straightness are required, to quasi-static optical metrology where high-accuracy and precise geometric performance are necessary. Regardless of the application, the Planar$_{DLA}$ is designed to meet a variety of application needs with an array of configurable options.

PLANAR$_{DLA}$-330XY

Features and Benefits

- Integrated, low-profile, XY, linear-motor stage with clear aperture
- Excellent geometric performance (straightness to ±0.5 µm, flatness to ±1.25 µm)
- Optimized for high-dynamic applications
- Speeds to 2 m/s and accelerations to 2g
- Integrated cable management
- Large selection – nine models in travel and accuracy

Microscopy Solutions

Easy to integrate piezo stages

Aerotech piezo nanopositioners are just another axis in a complete motion system.

Aerotech's QNP series piezo stages, controls, drives, and software make positioning to nanometers incredibly easy. QNP stages are available in linear, XY, Z, and high-dynamic versions. Each QNP stage is capable of sub-nanometer resolution and nanometer-level linearity in high-throughput processes. The Ensemble QLAB stand-alone controller supports up to four axes of piezo motion with advanced controls. The Ndrive QL/QLe panel-mount piezo drives are designed for use with the high-power Automation 3200 (A3200) motion controller. These drives enable coordinated motion between piezo stages and servo axes and access to the extensive A3200 software library is at your disposal.

Features and Benefits

- Family of X, XY, and Z piezos and dynamic focusing modules
- Open and closed-loop feedback options
- Stand-alone and PC-based control solutions available
- Comprehensive software tools for diagnostics, tuning, and programming
- Advanced control features such as Learning Control, Harmonic Cancellation, and Command Shaping improve tracking error and overall process throughput

Microscopy Solutions

High-dynamic piezo stages

A multitude of microscopy applications require high-dynamic Z motion to allow for extremely fast surface tracking rates when performing operations like autofocus. Aerotech's QNP_{HD} series single-axis direct-drive piezo stages, along with our easy-to-integrate controls, provide a one-stop, seamless solution for these scanning needs.

Features and Benefits

- Closed-loop travels from 10 µm to 40 µm
- Direct-drive actuation enables fast response times and higher-throughput processes
- High-precision, frictionless flexure guidance
- Long device lifetime
- Superior positioning resolution and linearity with direct-metrology capacitive sensor option
- Open-loop and vacuum versions

Microscopy Solutions

Objective lens dynamic focusing module

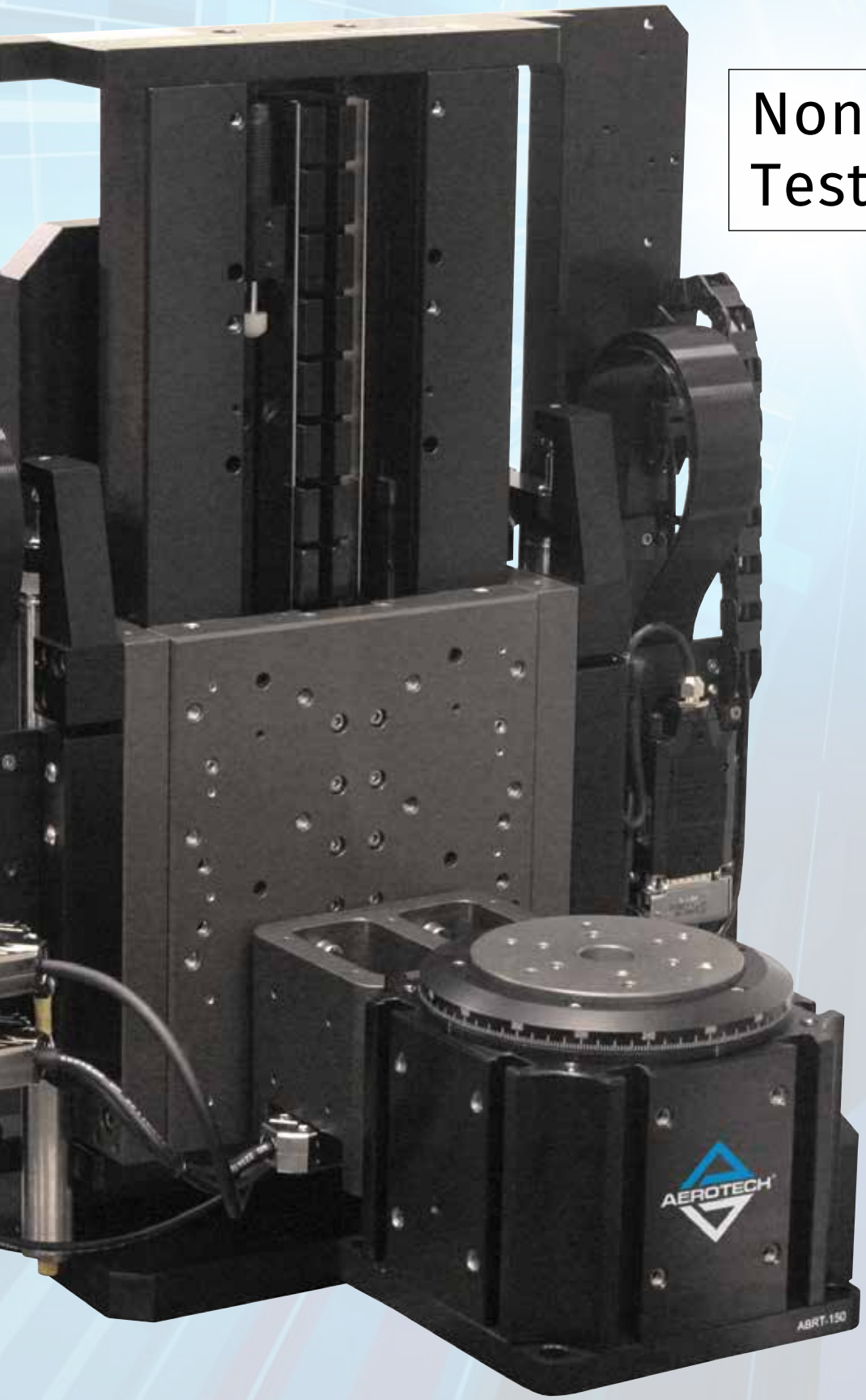
QFOCUS™ QF-46

Aerotech's QFOCUS™ nanopositioner enables microscope objective and optics positioning at high-bandwidth with nanometer-level performance. The QF-46 is designed with next-generation optical instruments and laser machines in mind. The QF-46 can perform better than competitive offerings with larger and heavier higher numerical aperture objectives due to its higher inherent stiffness. The QF-46 is perfect for any demanding optical application requiring high precision and throughput with long travels.

Features and Benefits

- Travels from 100 µm to 300 µm
- High-stiffness and dynamics resulting in outstanding step-and-settle and scanning performance
- High-precision, frictionless flexure guidance
- Long device lifetime
- Superior positioning resolution and linearity with direct-metrology capacitive sensor option
- Mounting flexibility with a variety of threaded adapters or mounting holes for custom mounting arrangements
- Clear aperture to 29 mm diameter

Nondestructive Test



X-Ray/CT Inspection

Objective lens dynamic focusing module

AGR-50 gear-drive rotary stage

PRO165 ball-screw linear stage

Planar$_{DLA}$

ABRS-200MP air-bearing, direct-drive rotary stage

Aerotech understands the challenges behind today's X-ray technology and has the components and stages to support all areas of X-ray and industrial CT inspection. As the tolerances for inspection get increasingly better, then so must the precision of the axes involved in the test procedure. This is why it is important to choose your products from a vendor that can supply not only what you need today, but also what you will need in the future.

Products

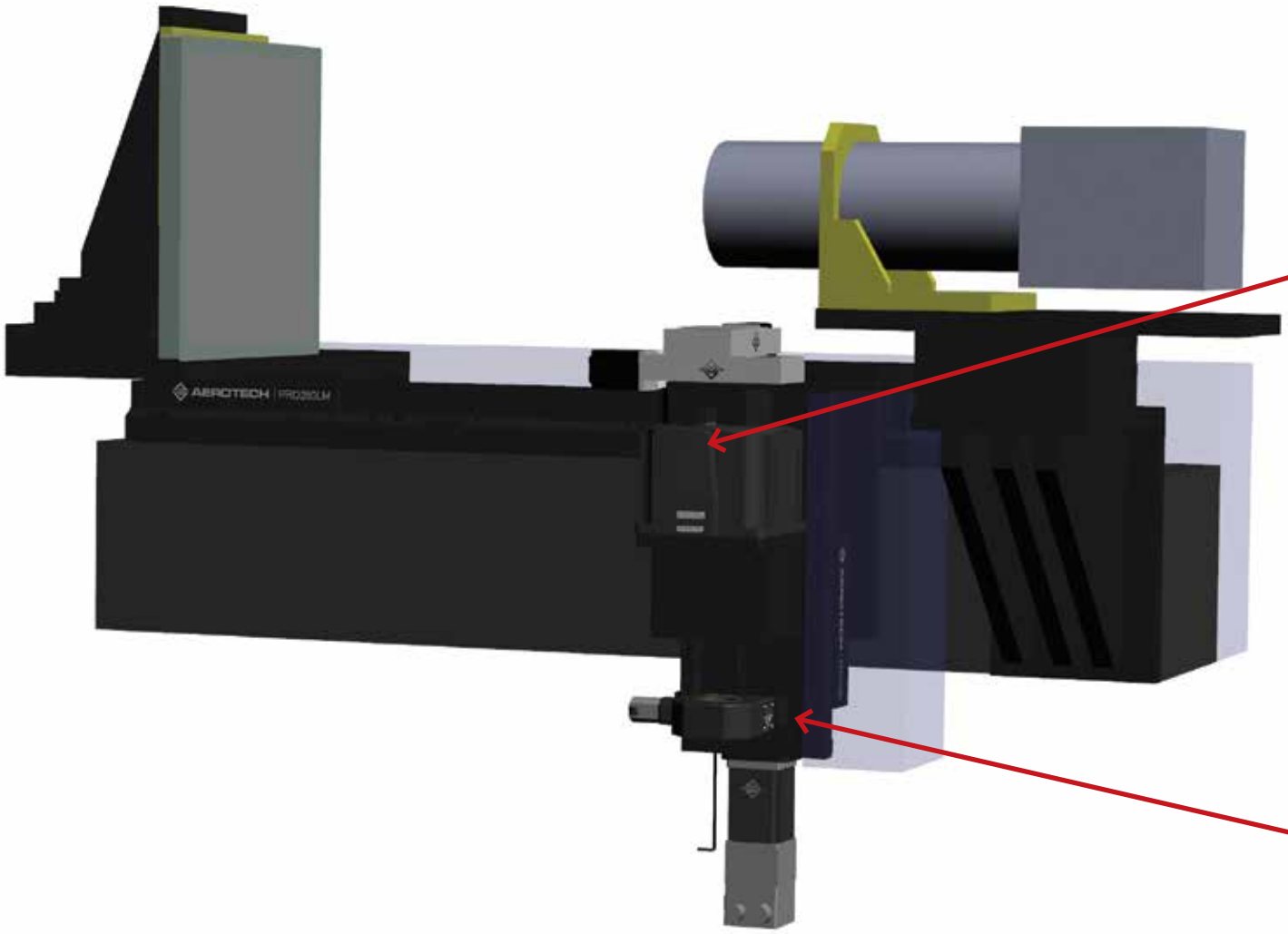
- PRO-SL ball-screw stages and PRO-LM linear motor stages
- AGR gear-drive rotary stage
- ADRS mechanical bearing, direct-drive rotary stage
- ABRS and ABRT air-bearing, direct-drive rotary stages
- Custom solutions

Features and Benefits

- Accurate low-speed operation
- High velocity stability
- Large selection of components
- Superior geometric performance greatly reduces unwanted error motions

X-Ray Inspection

Precision stages for integration into X-ray/CT platforms



Solutions....

- Precision rotary axis for test artifact motion
- Linear axes for detector motion
- Custom design “set-and-forget” axes

Features and Benefits

- Accurate low-speed operation
- High velocity stability
- Control solutions available for all axes
- Large selection of components

APR150DR

PRO225LM

X-Ray Inspection

Custom solutions for X-ray/CT platforms

Custom Z-theta air bearing system

Rack-mount and discrete drives available

Some X-ray inspection machines require different axes with varying degrees of precision. Many times the axes not used during testing only require ball screw or gear-driven technology, while the test axes can require direct-drive motion or even air-bearing-level precision. At Aerotech we have a wide range of stages and components to meet all of the needs of X-ray inspection machines.

Features and Benefits

- Superior positioning accuracy
- Real-time stage positional information
- Custom configurations available

Ultrasonic Testing

Custom platforms for acoustic non-destructive test

Custom XYZ
gantry system

Whether you are in search of a complete ultrasonic testing machine or only the components to build your own system, Aerotech has a solution. Our large selection of ball-screw stages, gear-driven rotaries, and linear motor actuators are complemented nicely by our extensive controls in order to provide you with the best solution, all from a single vendor.

Products

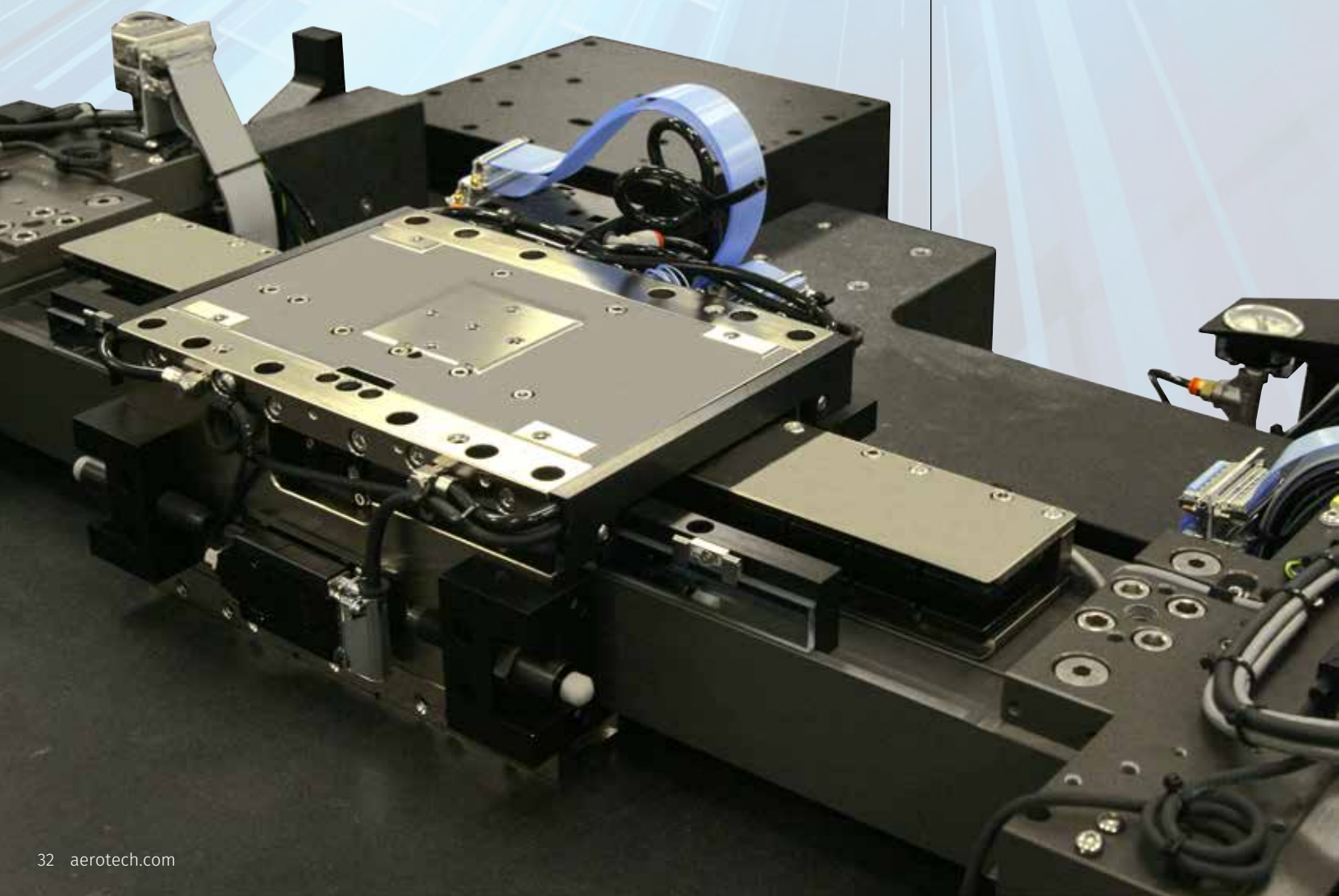
- PRO-SL ball-screw linear stage
- ACT linear actuator
- Linear amplifiers
- Rack-mounted amplifiers
- Linear and rotary motors
- Custom configurations

Features and Benefits

- Cost effective
- No radiated electrical noise
- Flexible solutions

Complete line of linear amplifiers and motors

Semiconductor Inspection and Metrology



Thin Film Measurement

Variety of stand-alone stages for film inspection

Aerotech has a multitude of linear, rotary, and Z stage options for two, three, and four-axis thin-film thickness and profile measurement tools. Each system has been designed to optimize throughput while minimizing thickness/profile direction geometric errors. All mechanics are designed to be fully cleanroom compatible by utilizing strict manufacturing methods, careful material selection, and thoughtful cable management designs. Aerotech's Ensemble controller, utilizing the ultra-compact Ensemble MP drive, provides a high-performance motion platform that requires minimal space.

PRO225LM XY

Applications

- Ellipsometry
- Reflectometry
- Scanning White Light Interferometry (SWLI)
- Stylus measurements

Products

- Ensemble MP PWM controller/drive
- High-performance linear motor stages (PRO-LM and ABL series)
- Low profile, direct-drive Z and rotary stages (WaferMax Z, WaferMax T, ADRS)

Features and Benefits

- Highly accurate closed-loop control
- Digital output encoder options
- Brushless, slotless motor for smooth motion with no cogging
- Low profile Z and theta stage options
- Rotary stage options with integral rotary union for vacuum chuck operation
- Vacuum chuck options with integral leveling mechanism

Thin Film Measurement

Low-voltage compact control electronics

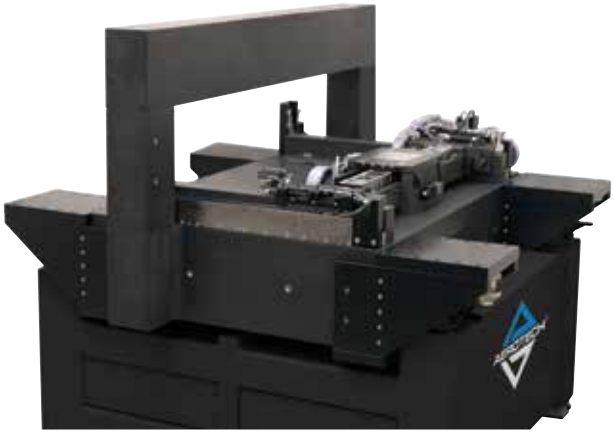
Ensemble ML10-40-IO MXH (linear) and
Ensemble MP10-IO-MXU (PWM) drives

Fab floor-space is at a premium, which forces tool manufacturers to provide the smallest machine footprint possible. In addition, a variety of machine safety standards must be satisfied. Compact drive electronics that can run on non-lethal voltages (48 VDC and below) and can be mounted just about anywhere in the tool are highly valuable when attempting to pass regulatory standards like Semi S2.

Aerotech's MP and ML drive options are compact, DC input compatible drives that provide nearly all of the control functionality of other drives but take up less than one-fourth the volume. Their compact size allows them to be mounted nearly anywhere and they are compatible with readily available 24 and 48 VDC supplies.

Wafer Inspection

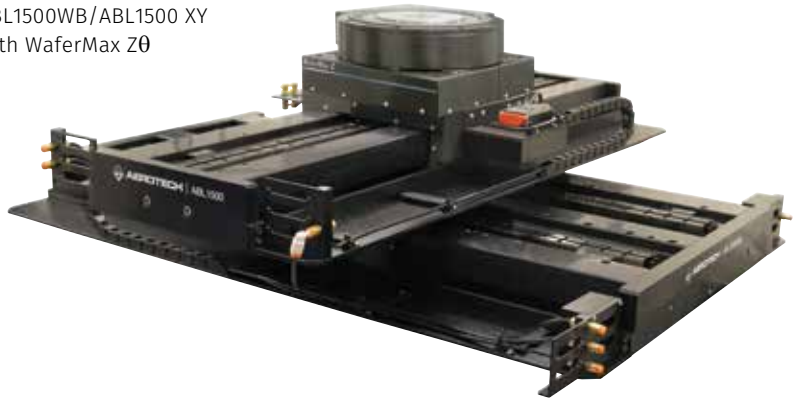
Multi-axis platforms for wafer inspection



ABL9000 motion platform with granite bridge/Z axis, optimized isolation system, and machine base

ABL1500WB/ABL1500 XY with pneumatically counter-balanced ABL1500Z

ABL1500WB/ABL1500 XY with WaferMax Zθ



An integral element of every wafer fabrication facility is its optical (lightfield and darkfield) inspection systems. These surface characterization tools detect a wide variety of defects including voids, pits, and scratches in the wafer surface. Smooth, high-speed raster scanning is required to meet the needs of today's fabrication facility. Aerotech's ABL9000 has long been the standard for this type of inspection by providing superior dynamic performance characteristics.

Products

- High dynamic stages (Planar$_{HD}$, ABL9000, ABL1500, Planar$_{HDX}$)
- Direct-drive rotary and Z-axis stages (WaferMax Z and WaferMax T)
- High performance A3200 control platform

Features and Benefits

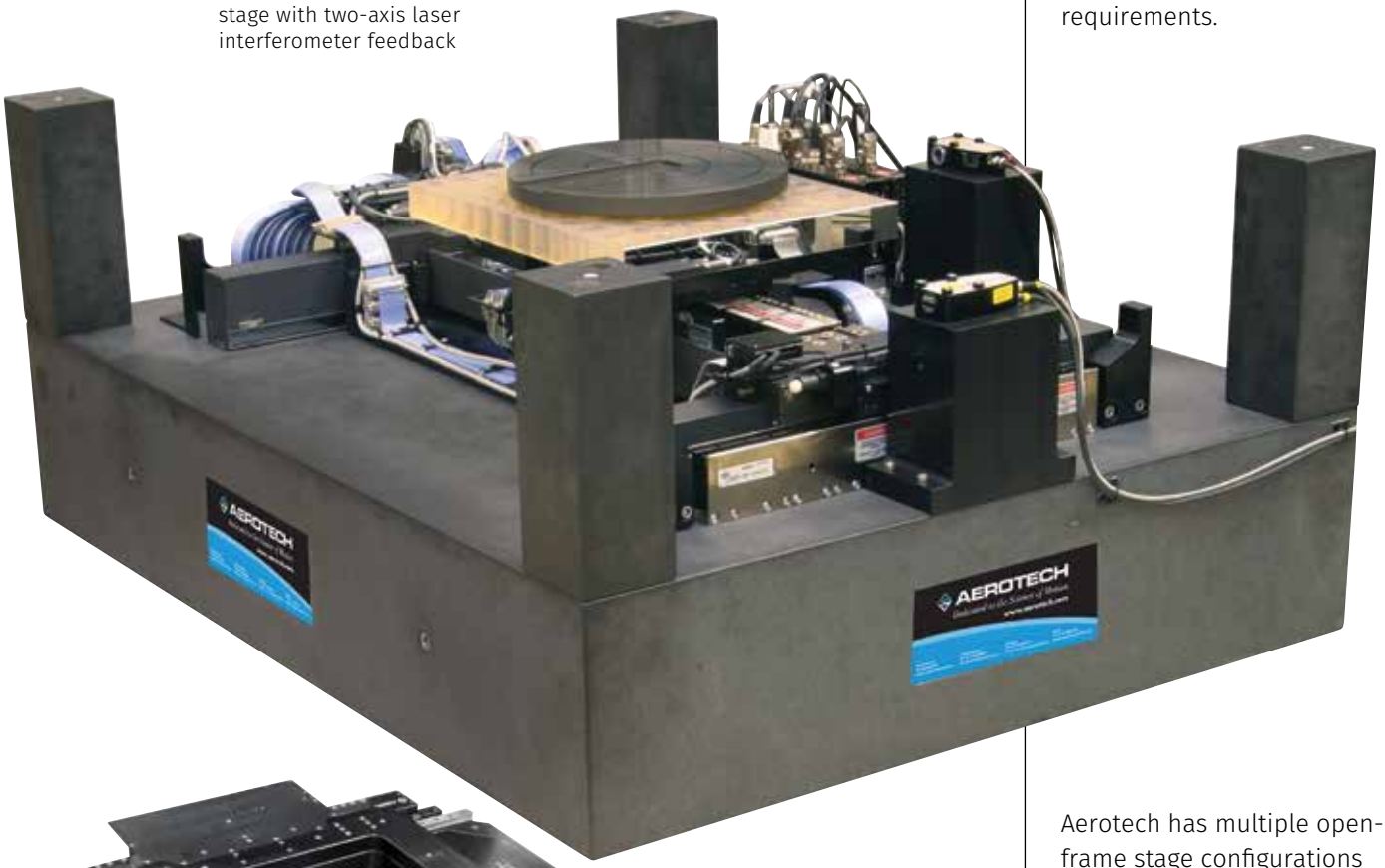
- Aerotech direct-drive linear motors maximize throughput
- Aerotech offers a wide variety of axes that can be mounted on an XY stage, including theta axes for pattern alignment and Z axes for focus adjustment
- Open-frame stages are available for microscopy applications
- Machine base and isolation system options available
- Custom systems available

Wafer Inspection

Multi-axis platforms for wafer inspection

The key to optical wafer measurement systems is their ability to accurately identify and measure defects while running at production line rates. This requires exceptionally stiff mechanical structures, motion profile generation, and responsive isolation systems. The system's ability to settle to a target scan velocity is key to meeting wafer-per-hour throughput requirements.

Custom ABL9000 air-bearing stage with two-axis laser interferometer feedback

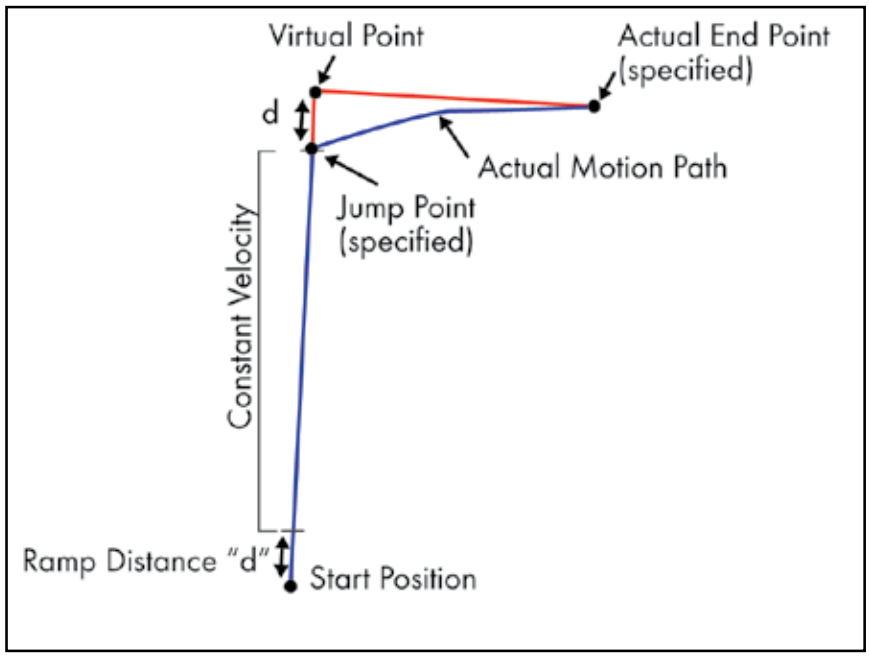


High throughput Planar$_{DLA}$ open-frame stage

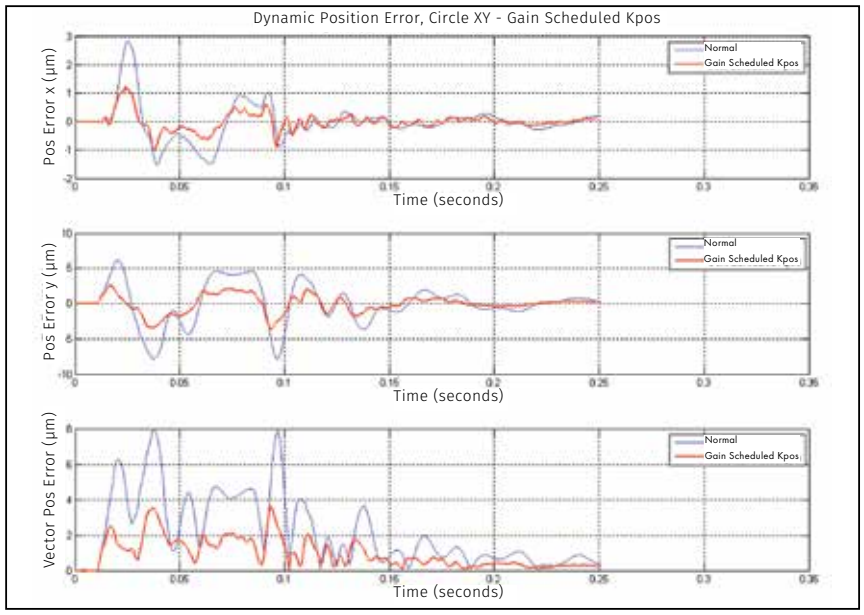
Aerotech has multiple open-frame stage configurations including air and mechanical-bearing systems ideally suited to optical wafer inspection applications.

Wafer Inspection

Advanced controls for raster scanning



Increase scanning throughput by blending step and scan into a contoured move.



Directional Gain Scheduling automatically adjusts gain based on error motion during settling.

Aerotech has developed move profile optimization routines that allow for faster settling after acceleration. The Slice command smooths the stage turnaround during raster scanning, and Directional Gain Scheduling reduces settling time by automatically adjusting gains based on error motions.

Slice Command

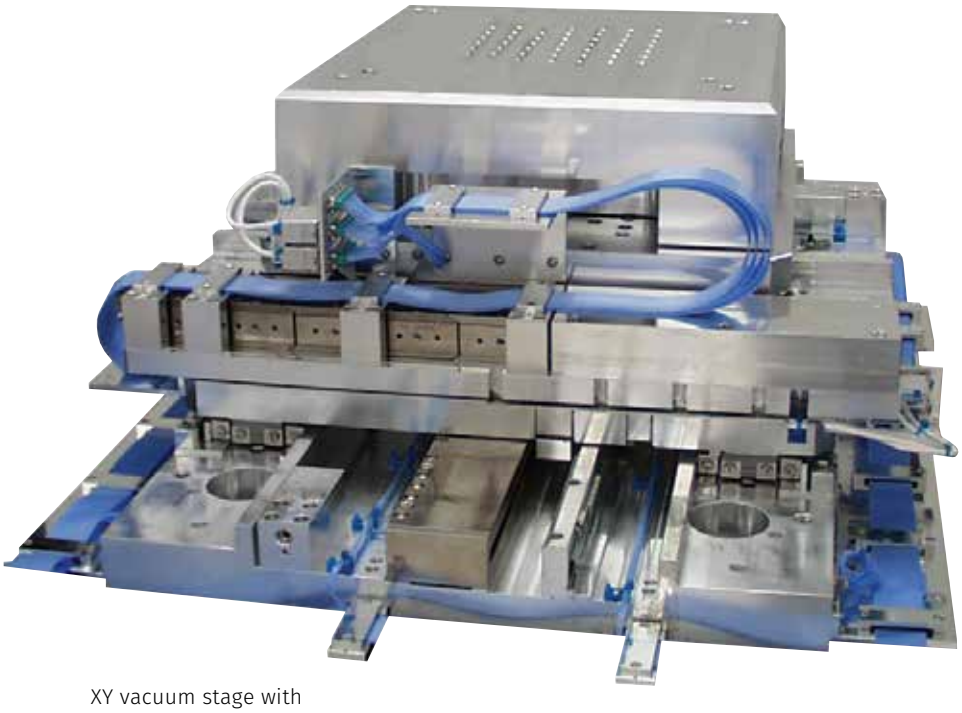
- Increase scanning throughput by blending step and scan into a contoured move
- Built-in function with easy to understand arguments
- Step move automatically initiates at the beginning of the scan axis deceleration
- Blended motion profile minimizes turnaround time

Gain Scheduling

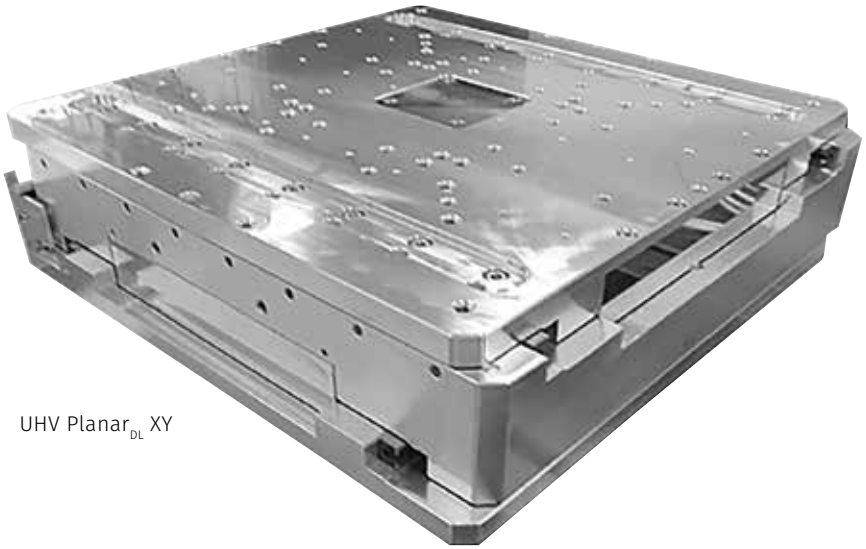
- Increase machine throughput
- Increase in-position stability
- Automatically adjusts gain based on error motion during settling
- Available through Aerotech's Dynamic Controls Toolbox (DCT)

Electron/Ion Beam Microscopy

Ultra-high accuracy vacuum stages



XY vacuum stage with special shielded magnets



UHV Planar$_{DL}$ XY

Electron/ion microscopy including transmission electron, scanning electron, and focused ion-beam microscopes provide exceptionally high-resolution images with large depths of field and have many other advantages over traditional microscopy. Strikingly clear images are obtained from samples ranging from biological specimens to semiconductor wafers. Regardless of the component under test, Aerotech has a variety of high vacuum, low magnetic field electromechanical solutions.

Aerotech has a long history of supplying vacuum compatible motion systems for a variety of applications including semiconductor inspection, satellite testing, and ion-beam profiling. Our application, engineering, and production staff are highly skilled and experienced with custom vacuum system solutions designed to meet specific testing needs of vacuum inspection systems.

Features and Benefits

- Standard and custom solutions
- High accuracy
- High throughput
- Low settling time
- Component or turnkey system capabilities
- Integrated Development Environment
- Advanced control techniques

Scanning Probe Microscopy

Ultra-stable SPM motion systems

Many inspection applications require tight positional stability, but few are as stringent as that for Atomic Force Microscopes (AFMs). Aerotech has multiple motion platforms that directly address the needs of Atomic Force Microscopy by providing nanometer step sizes and single-digit nanometer positional stability. The recommended platforms are all direct-drive, direct-feedback devices that undergo extensive testing to ensure top-notch accuracy and stability performance.

Products

- Ultra-stable multi-axis motion platforms (ABL9000, ANT95-XY, ANT130-XY)
- Low noise, high-resolution control electronics (Ndrive HLe, Npaq/DL4010, Ndrive ML)
- Alternative construction materials to minimize thermal issues

300 mm wafer class ABL9000 planar air-bearing

Aerotech's ABL9000 can be "locked" in both X and Y to dramatically increase positional stability over time. Specially designed methods are used to control the locking procedure while maintaining positional information. This ensures that the user always knows where the sample is positioned regardless of the locking condition.

Features and Benefits

- A3200 motion controller with rack mount or discrete linear amplifiers
- High performance integrated XY linear motor stages – air bearing and mechanical bearing
- Ultra-stable motion platform provides very tight in-position stability and minimal drift

Scanning Probe Microscopy

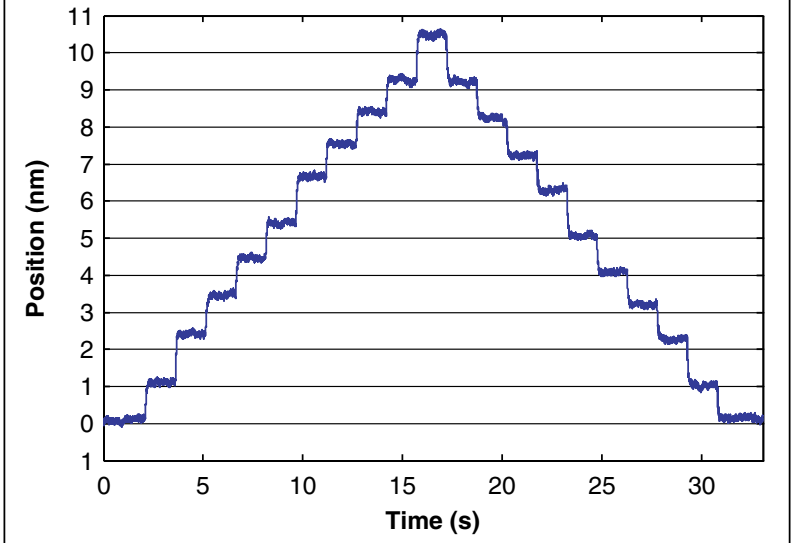
Complete systems for AFM/ scanning probe microscopes

Scanning probe microscopes produce exceptionally high-resolution images of very complex geometric features. The challenge is finding a motion platform that provides very accurate positioning and minimal error motion when settling in position. Aerotech has a multitude of motion platforms to maximize positional stability and settling performance.

ANT130-XY

ANT95-XY-ULTRA

Invar ALS130-XY with pneumatically counterbalanced Z axis is specifically designed to dramatically increase thermal stability



1 nm step plot for ANT95-XY-ULTRA

Discrete or rack-mount linear amplifier options

ANT180-XY stage system

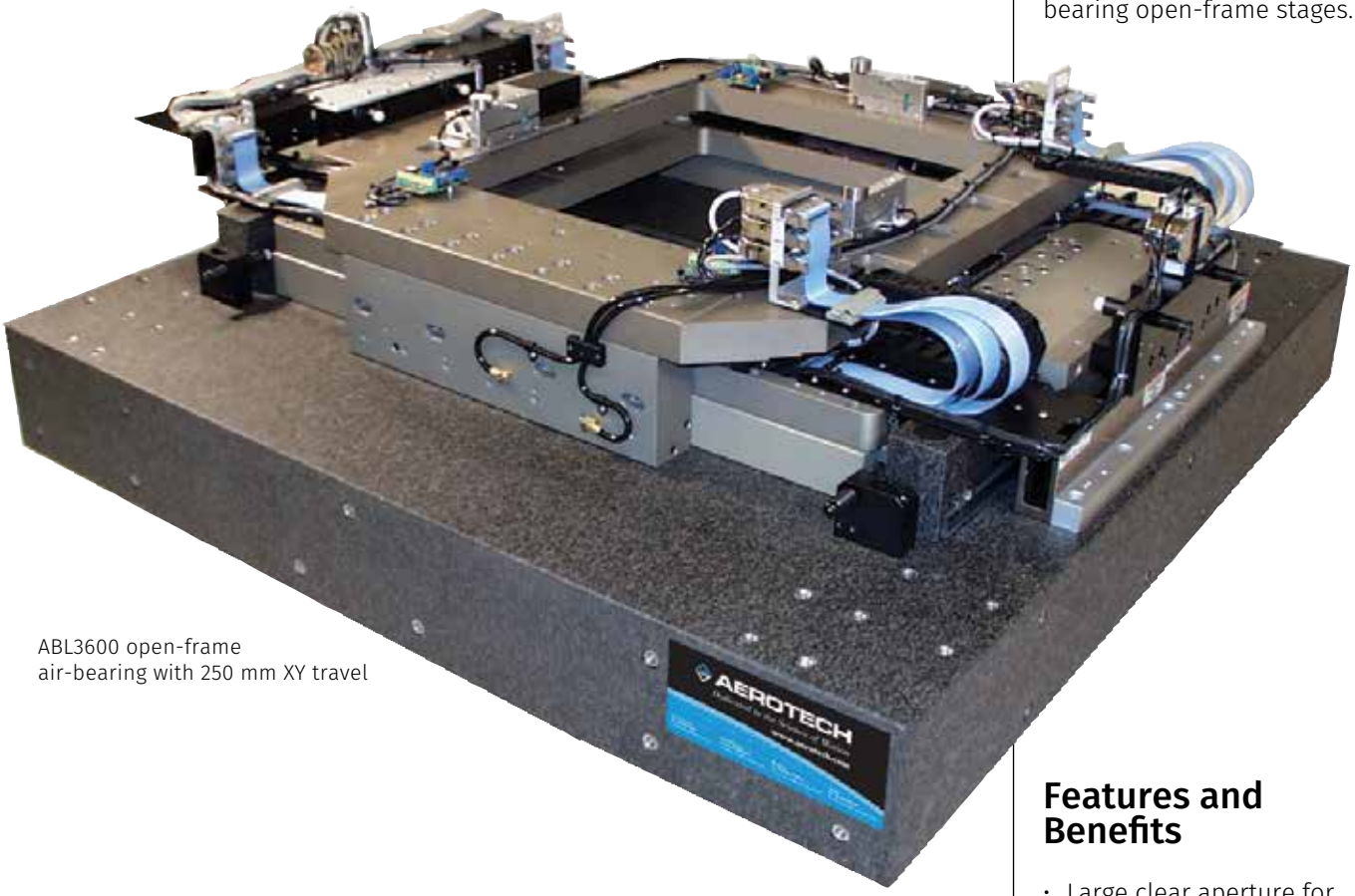
Reticle/Mask Inspection

Ultra-high accuracy mask inspection stages

Reticle inspection requires a unique combination of mechanics that provides both ultra-high accuracy and a large clear aperture. The combination of high stiffness air bearings and dual linear-motor-driven axes provides an XY open-frame stage with exceptional performance characteristics. The ABL3600 represents a major upgrade in performance over traditional mechanical-bearing open-frame stages.

Products

- ABL3600
- Planar$_{DLA}$
- Custom tip-tilt
- A3200 controller
- Npaq drive chassis



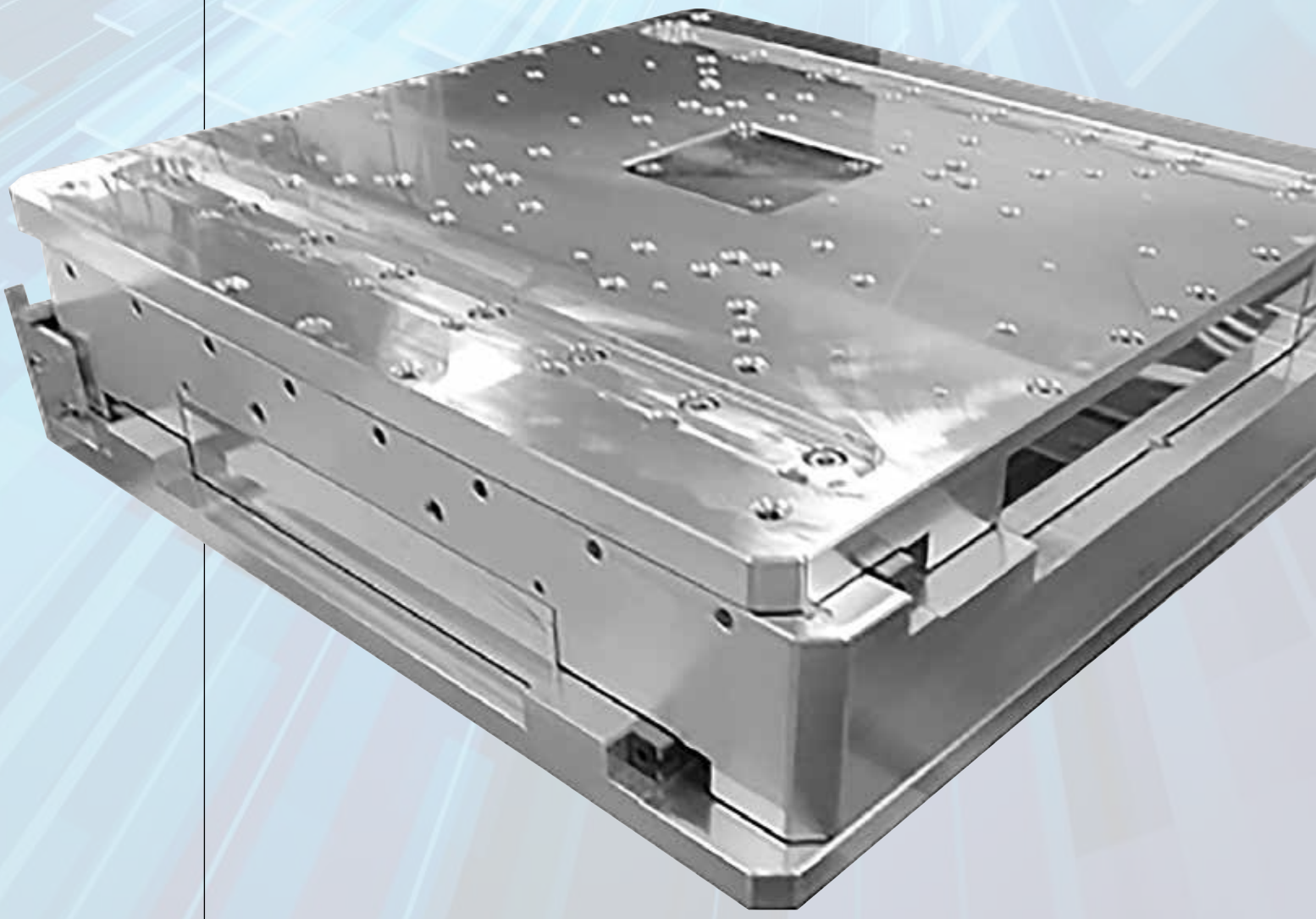
ABL3600 open-frame
air-bearing with 250 mm XY travel

Automation 3200 (A3200) multi-axis machine controller

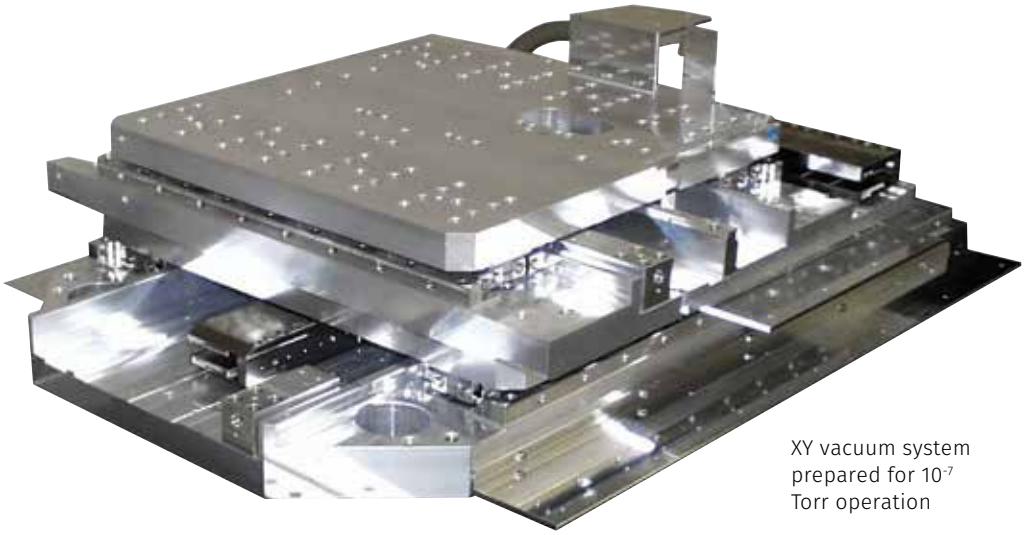
Features and Benefits

- Large clear aperture for inspection and illumination
- Dual linear-motor-driven axes provide excellent yaw performance
- Exceptional system stiffness
- Brushless, slotless motor for ultra-smooth motion
- Linear encoder or laser interferometer feedback

Vacuum and Cleanroom Systems



Vacuum Applications



XY vacuum system prepared for 10^{-7} Torr operation

High-vacuum MPS75SL stage with 100 mm travel

Aerotech's vast application experience, unmatched product scope, and extensive engineering capabilities make us the partner of choice for vacuum compatible motion systems.

Vacuum Options Available from Aerotech

- Low vacuum option (10^{-3} Torr)
- High vacuum option (10^{-6} Torr)
- Ultra-high vacuum option (≤10^{-7} Torr)

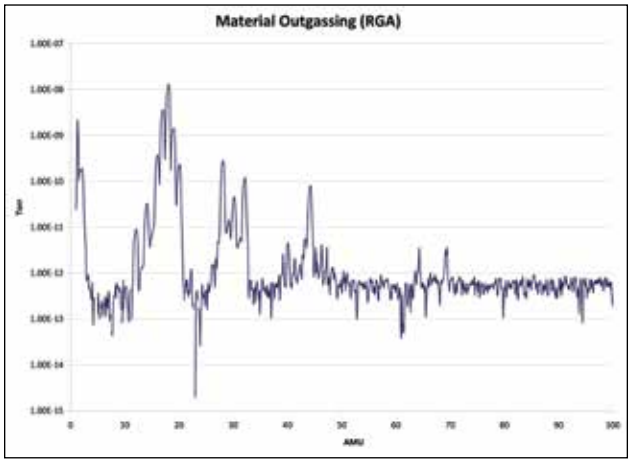
Aerotech Has Specific Experience with Vacuum-Compatible Motion Platforms

- Material selection
- Surface preparation
- Hardware venting and elimination of trapped volumes
- Lubricant selection
- Thermal management
- Magnetic field control
- Cleaning
- Bake-out
- Handling and packaging

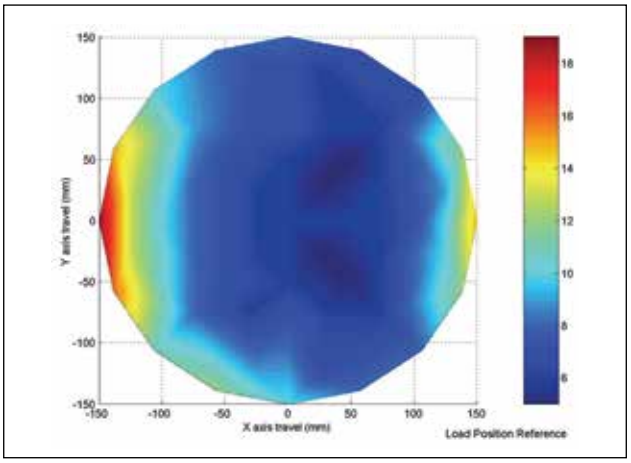
Aerotech's Vacuum Experience Includes a Wide Variety of Applications

- Satellite component testing
- Scanning electron microscopy (SEM)
- E-beam inspection
- EUV lithography
- Ion-beam profiling
- Ion implantation
- Deposition
- Optics polishing

Vacuum Applications



Actual RGA plot from an XY system



Actual magnetic field measurement over a 300 mm diameter target zone

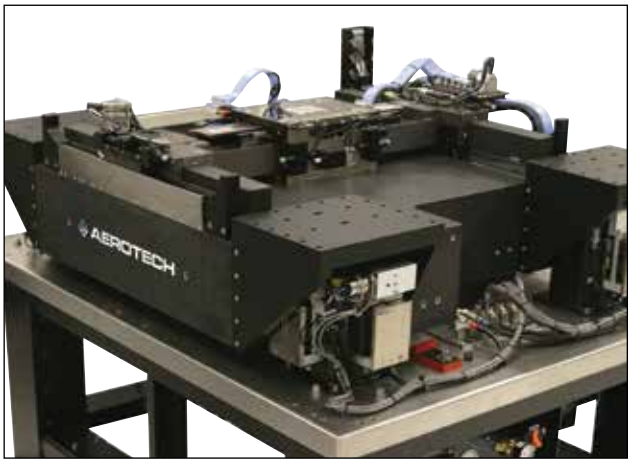
UHV (10^{-7} Torr) ADRS-100 direct-drive rotary stage with unlimited travel

UHV (10^{-7} Torr) $Planar_{DL}$ with 200 mm of XY travel

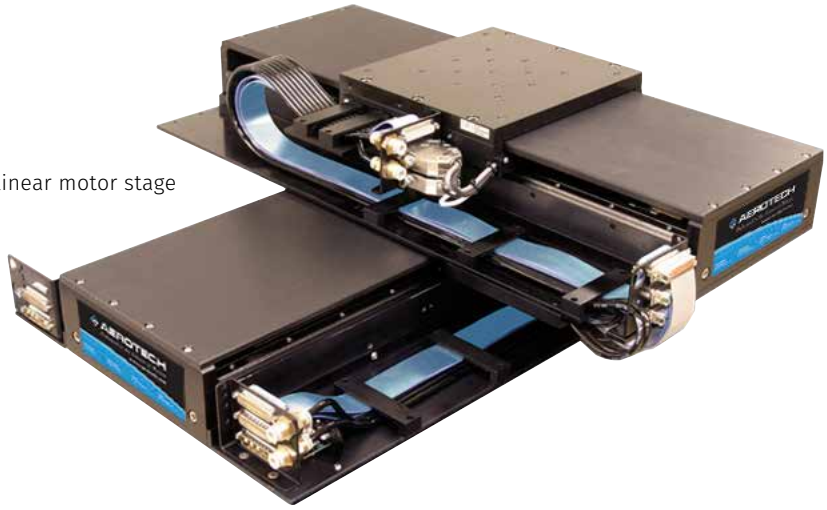
Multiple configurations available

Cleanroom Capabilities

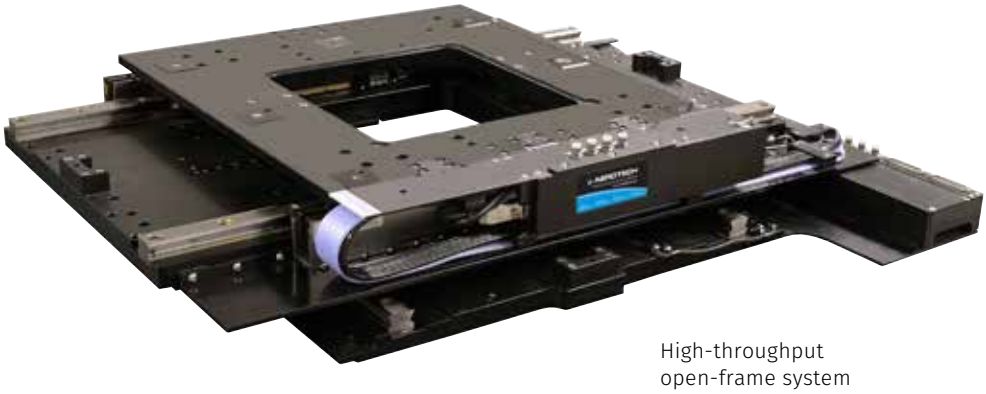
Complete facilities and design practices



ABL9000 planar air-bearing with custom isolation system



ALS20000XY linear motor stage



High-throughput
open-frame system

Aerotech manufactures a diverse assortment of cleanroom compatible motion solutions for high-performance applications such as wafer inspection and metrology.

Aerotech's Cleanroom Facility

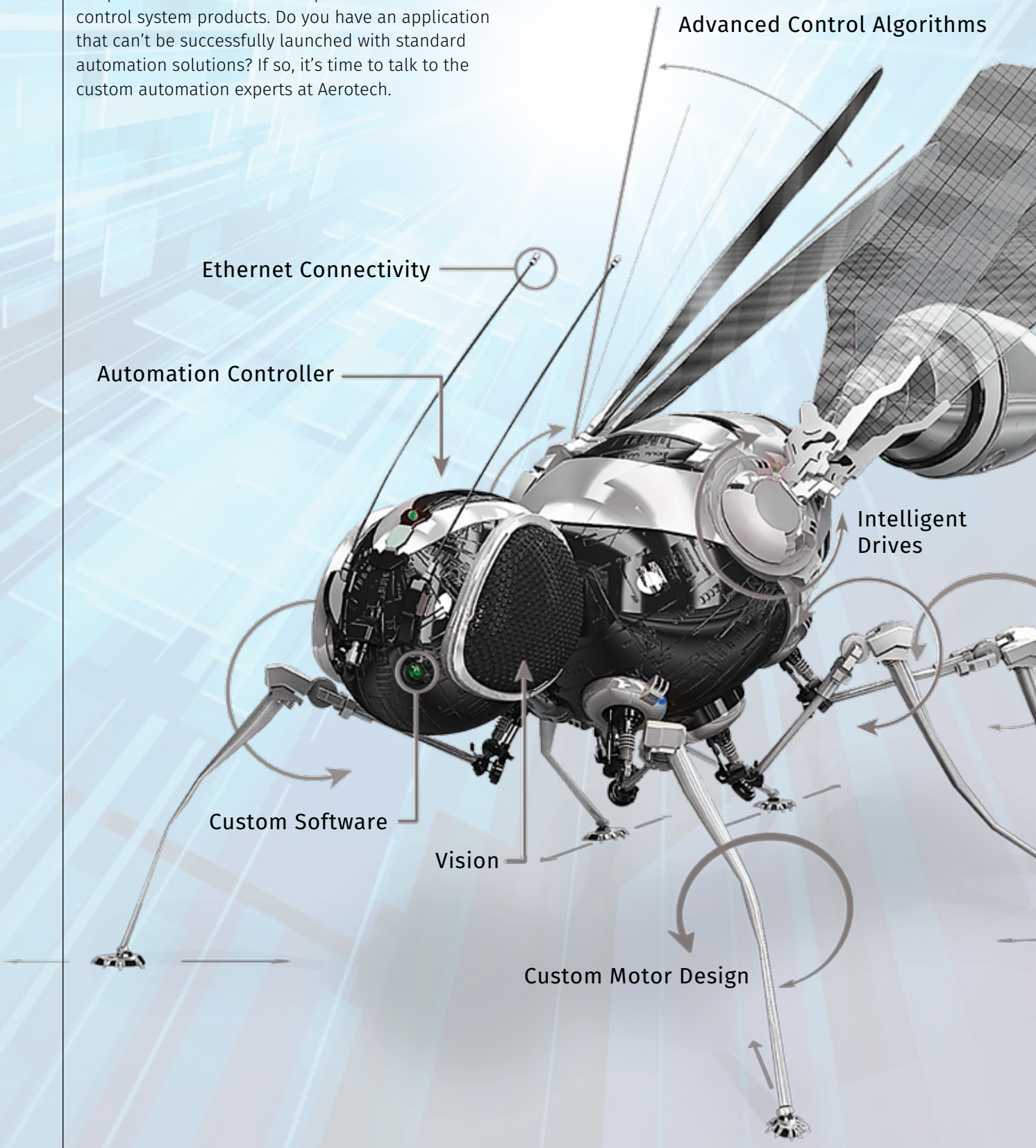
- ISO Class 6
- Cell specific ISO class 5 areas
- Temperature control to ±0.1 degree C
- Dedicated product transfer and large main product assembly areas
- Actively-isolated granite surface plates for testing purposes

Features and Benefits

- Low particulate generating cable management systems
- Cleanroom compatible, hydrocarbon-free lubricants
- Special material surface treatments
- Manufacturing processes that are specifically designed to maximize system-level cleanliness
- Cleanroom packaging

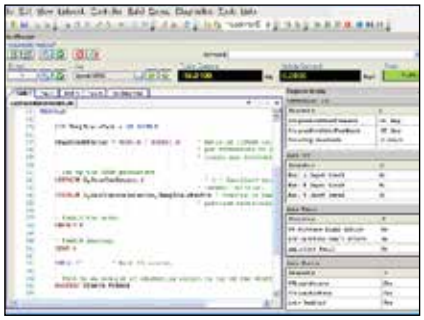
Machine Automation

We used this fanciful mechanized insect to illustrate the powerful customization capabilities of our control system products. Do you have an application that can't be successfully launched with standard automation solutions? If so, it's time to talk to the custom automation experts at Aerotech.



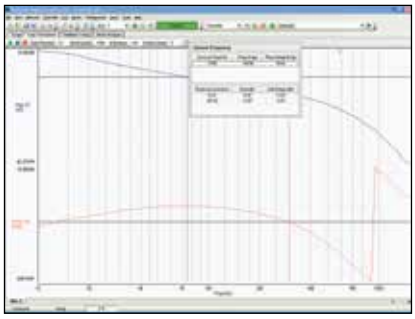
Aerotech Integrated Automation Solutions

- Common Software Platform: Tools, Powerful Programming Environment, Calculators, Diagnostics



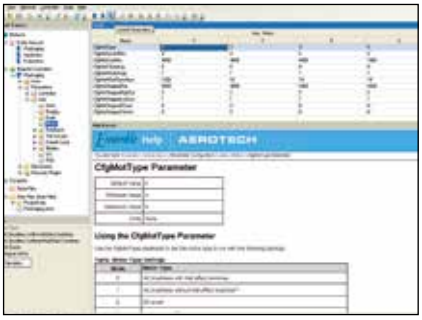
Programming Interface

EasyTune

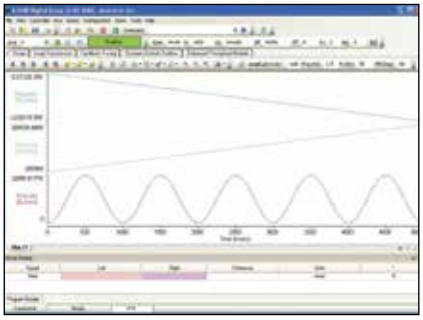


Loop Transmission

- Use the libraries and SDK to develop your own applications with .NET, C#, VB.NET, C, or LabVIEW®



Parameter Editor



Digital Scope

MotionPAC

Accessories

- Handwheel/joystick
- ESTOP
- Rack-mount configuration
- Rack-mount PCs

Network and Fieldbus Connectivity

- Ethernet/IP™
- Modbus®/TCP
- DeviceNET
- Ethernet TCP/IP
- USB
- RS-232
- GPIB

Configure Your Automation Solution with Aerotech

- High performance
- Easy to use
- Flexible
- Scalable
- Networked
- Lowest cost of ownership
- Advanced control technology

Aerotech Integrated Automation Solutions

Automation 3200

Ensemble

Soloist

Automation 3200

- PC-based
- 1 to 32 axes of coordinated motion
- RS-274 (G-code)
- Advanced features for demanding applications
- PWM or linear drives (up to 150 A)
- Scanner control for marking
- Tightly integrated laser functionality
- Retrofit package for old controls
- Integrated PLC – MotionPAC

Ensemble

- Stand-alone
- Network up to 1,024 single axes
- Up to 4 tasks
- PWM or linear drives (10-150 A peak)
- Drives brushless, linear, rotary, DC brush, or stepper motors
- Desktop, rack mount, or panel mount

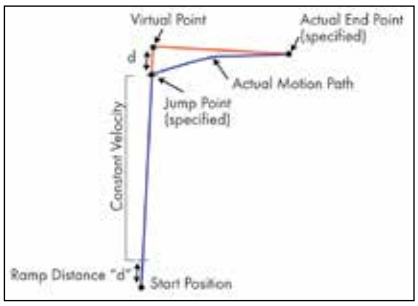
Soloist

- Stand-alone
- Up to 4 tasks
- PWM or linear drives (10-150 A peak)
- Drives brushless, linear, rotary, DC brush, or stepper motors

Standard Controls

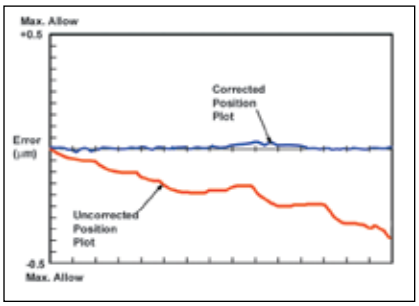
Aerotech controllers offer the broadest array of programming interfaces and core motion capabilities of any automation system available today for both OEMs and end-users alike.

Slice Move



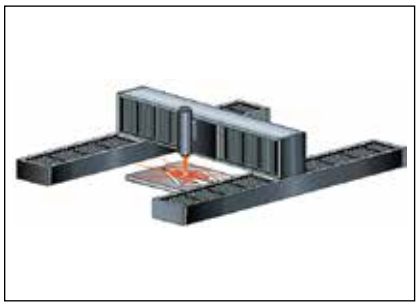
Increase scanning throughput by blending step and scan into a contoured move

Axis Calibration



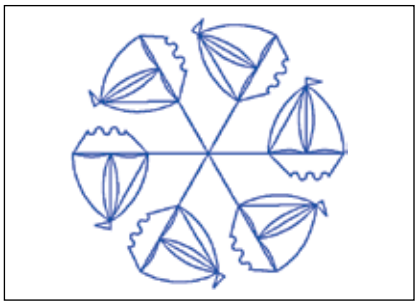
Compensate for repeatable mechanical errors in a positioning system

Gantry Mode



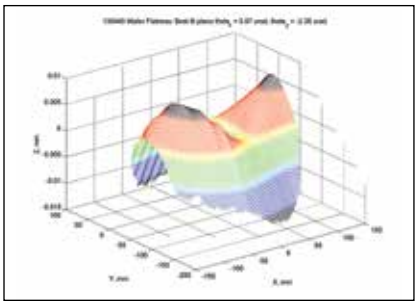
Complex gantry control is reduced to a few simple commands to handle dual motor and/or dual feedback configurations

Parts Rotation



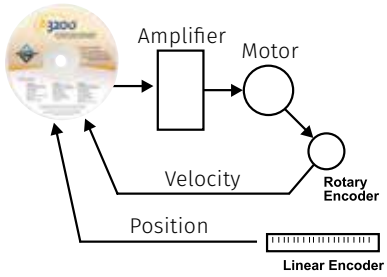
Use when a two-dimensional part must be repeated in different orientations without translating the part program many times over

3D Error Correction



Measure XYZ errors and the controller can correct the commanded position to accurately move to all locations in the 3D space

Dual-Loop Control

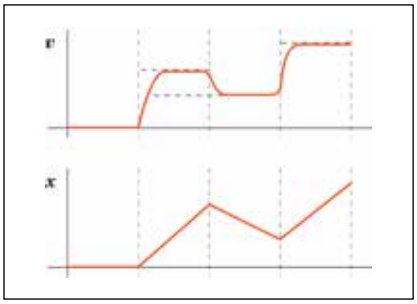


Dual-loop control is used to eliminate the effects of backlash and other sources of error

Laser Interferometer

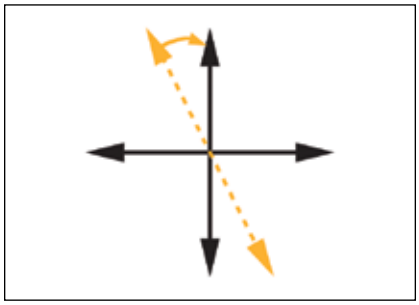
Systems requiring ultra-high resolution and feedback stability use interferometer feedback

Velocity Blending



The velocity changes to the next velocity command, acceleration limited, without stopping

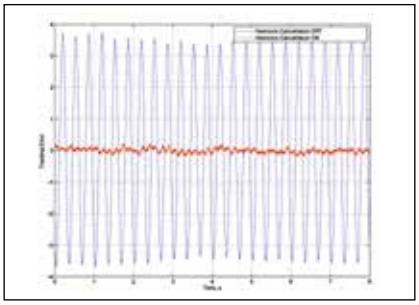
Orthogonality Correction



Improve X-Y planar accuracy by simply entering the known orthogonality error and the controller will compensate

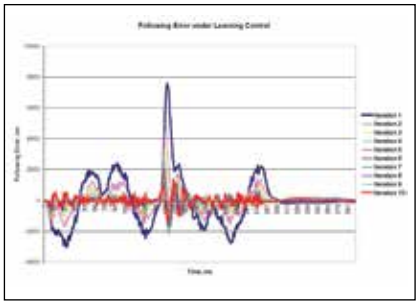
Advanced Controls

Harmonic Cancellation



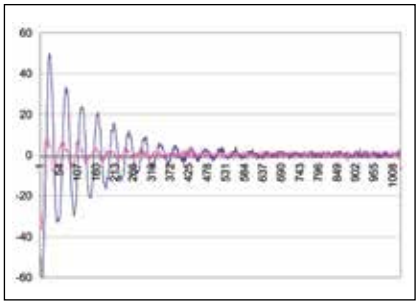
Reduce position error on periodic trajectories and reject periodic disturbances

Iterative Learning Control



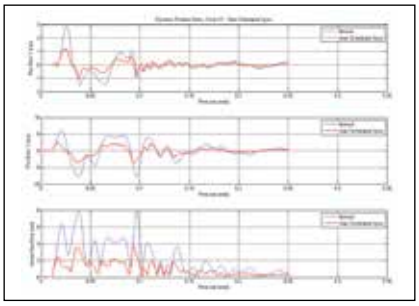
Reduce following error on repeated move sequences that can be learned and optimized

Enhanced Throughput Module (ETM)



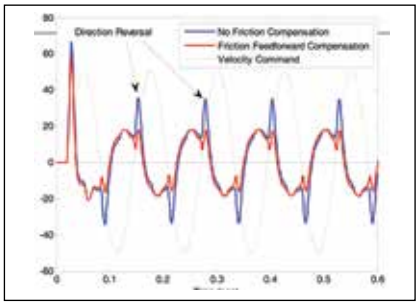
Increase rate stability and decrease settle times in the presence of vibration

Directional Gain Scheduling



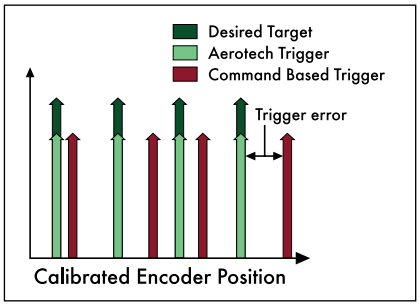
Decrease settle time and increase in-position stability

Friction Compensation



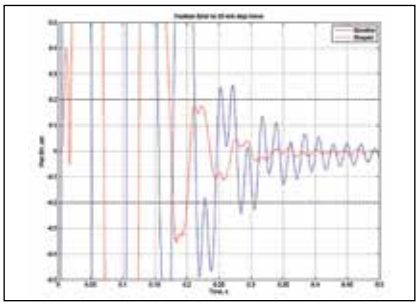
Reduce settle time and reduce error at direction reversals

Position Synchronized Output (PSO)



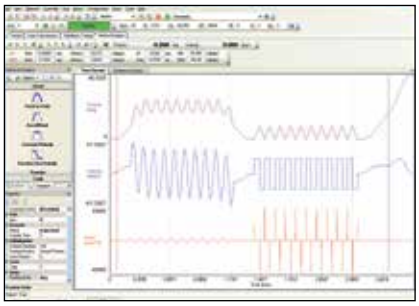
Trigger external events precisely at desired position while in motion

Command Shaping



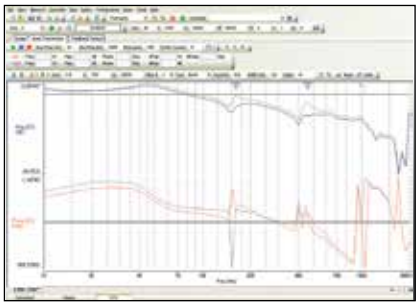
Reduce vibration at the work point

Motion Designer



Graphical trajectory generation and data analysis

Loop Transmission

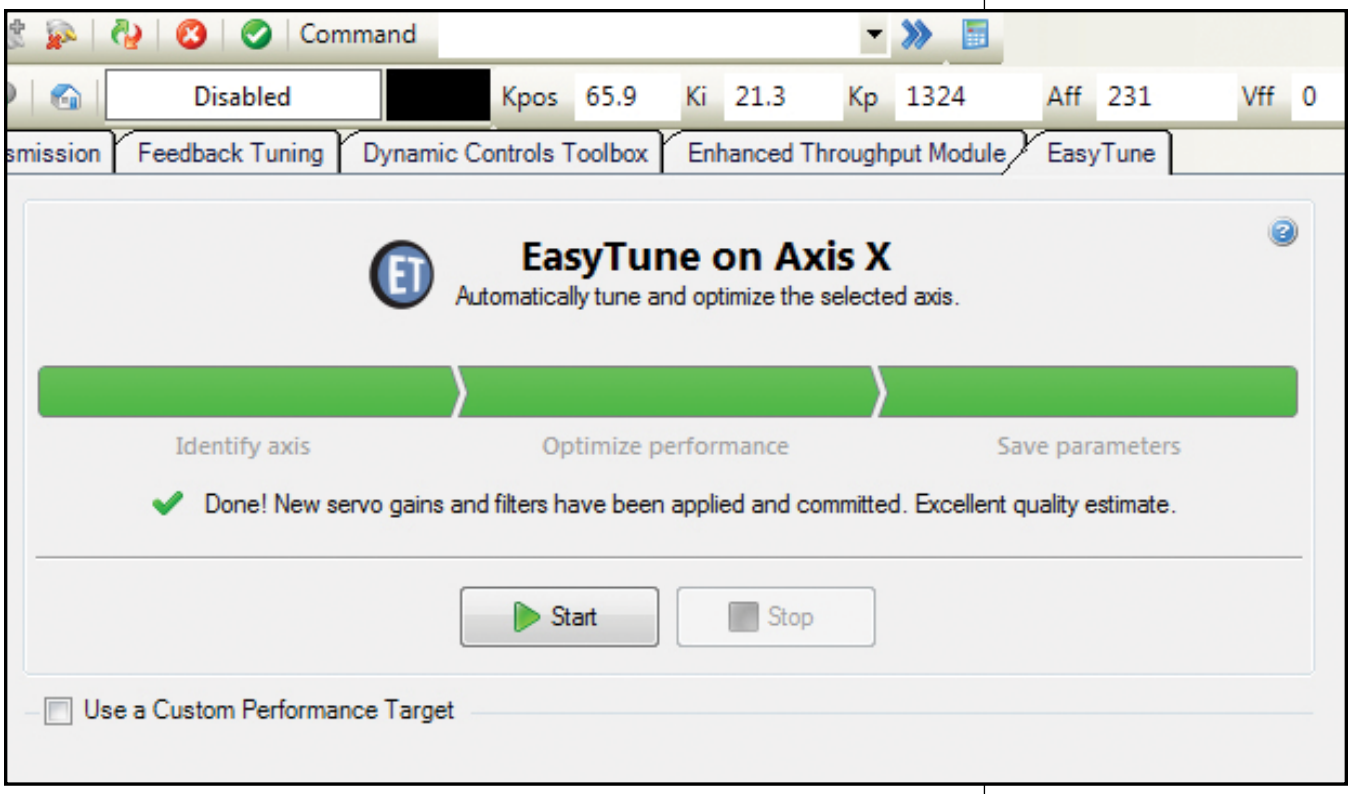


Tuning and diagnostic utility that greatly enhances system performance

EasyTune

Tune your system with one click

EasyTune® is the most advanced autotuning tool available in a commercial motion controller. The algorithm largely mimics the process followed by an experienced controls engineer. EasyTune directly measures and compensates for both machine and resonance non-linear behavior. It assumes no prior knowledge of the system properties and the final controller has the highest bandwidth practical for that particular stage system.



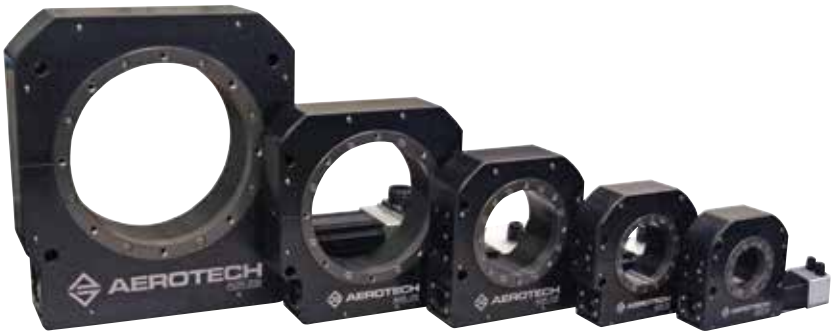
EasyTune requires no input from the user, completes in a few minutes, and provides measured verification of the servo performance when complete. EasyTune is a standard feature of the A3200.

A Wide Variety of Amplifier Options

	MP	CP	HPe	HLe	ML	Integrated Drive Racks	
A3200 Drives						 Npaq®, Npaq MR, or HEX RC drive chassis	
Ensemble Controls						 Ensemble Epaq, Epaq MR, LAB, QLAB, or QDe drive chassis and motion controller	
Soloist Controls						N/A	
Axes	1	1	1	1	1	1 to 8	1 to 8
Output Type	PWM	PWM	PWM	Linear	Linear	PWM and Linear	PWM and Linear
Peak Current Output	10 A	10-30 A	10-150 A	10-20 A	10 A	Npaq: 10-30 A Npaq MR: 10 A Hex RC: 10 A	Epaq/Epaq MR: 10 A Epaq: 10 A Ensemble LAB: 5 A Ensemble QLAB: 300 mA Ensemble QDe: 250 mA
DC Bus Voltage	10-80 VDC (Output)	10-320 VDC	10-320 VDC	±40-80 VDC	±40 VDC	Npaq: 10-320 VDC Npaq MR: 10-80 VDC Hex RC: 80 VDC	Epaq: 24-90 VDC; ±10-40 VDC Epaq MR: 10-80 VDC Ensemble LAB: ±24 VDC Ensemble QLAB: -30 to +150 V Ensemble QDe: -30 to +150 V
Standard I/O	1-AI	6-DI/4-DO 1-AI/1-AO	6-DI/4-DO 1-AI/1-AO	6-DI/4-DO 1-AI/1-AO	6-DI/4-DO 1-AI/1-AO	Multiple Configurations Available	1-AI per axis
Optional I/O	8-DI/8-DO 1-AI/1-AO	16-DI/16-DO 1-AI/1-AO	16-DI/16-DO 4-AI/4-AO	16-DI/16-DO 4-AI/4-AO	16-DI/16-DO 1-AI/1-AO	Multiple Configurations Available	Multiple Configurations Available
Incremental Encoder	✓	✓	✓	✓	✓	✓	✓
Absolute Encoder		✓	✓	✓			✓
Resolver/ Inductosyn			✓	✓		✓	
Capacitive Probes					✓	✓	
Laser Interferometer						✓	
All units capable of sinusoidal commutation, dual-loop control, and drive brushless, brush, or stepper motor							

Rotary and Linear Motion

Rotary Motion Solutions



AGR Series

AGR Series Large Aperture, Gear-Drive Rotary Stages

- Enhanced speed and load capacity
- Large aperture addresses a wide range of applications
- Useful for heavy and unbalanced loads
- Non-back-driving gear

ADRS Series

ADRS Series Low Profile, Direct-Drive Rotary Stages

- High torque output, direct-drive brushless servomotor
- Cog free, slotless motor design for superior velocity stability
- Direct coupled, high-accuracy rotary encoder
- Ultra-low-profile minimizes working height

ADRT Series

ADRT Series High Torque Output, Direct-Drive Rotary Stages

- Cog-free brushless servomotor design for outstanding velocity stability
- Large-diameter clear aperture
- High load capacity and high speed
- 5-60 arc-second accuracy

APR Series

APR High-Accuracy Rotary Stages

- Accuracies up to 1.5 arc second
- Axial load capacity up to 250 kg
- Incremental or absolute encoders
- Large bearings provide high payload and moment load capacity
- 375-800 rpm continuous rotation speed
- Seven models are available, each with either 50, 75, or 100 mm clear aperture

ALAR Series

ALAR Series

- 100 mm, 150 mm, 200 mm, 250 mm, and 325 mm apertures
- Axial load capacity to 600 kg
- Excellent accuracy and repeatability
- Cog-free motor provides smooth motion
- No gear backlash
- No accuracy change over time from gear wear
- 45-300 rpm continuous rotation speed
- High resolution gives excellent stepping and in-position stability

ABRS Series

ABRS Series, Low Profile, Direct-Drive Rotary Air-Bearings

- Excellent radial, axial, and tilt error motions
- Direct coupled, high-accuracy rotary encoder
- Low profile, planar design
- Axial load capacity to 97 kg

ABRT Series

ABRT Series, High Accuracy, Direct-Drive Rotary Air-Bearings

- High torque output, direct-drive slotless, brushless servomotor
- Zero-cogging motor for outstanding velocity stability
- Excellent radial, axial, and tilt error motions
- Direct coupled, high-accuracy rotary encoder
- Large-diameter clear aperture
- No mechanical contact
- Fully constrained air-bearing can be run upside down or on its side
- Axial load capacity to 69 kg

Linear Motion Solutions

MPS Series

MPS Series

- 50 and 75 mm widths
- Travel to 100 mm
- Precision ground ball-screw or lead-screw drive
- DC servo or stepper motor
- Crossed-roller bearings
- Compact multi-axis configurations

PRO-SL/SLE Series

PRO-SL and PRO-SLE Series

- Improved second-generation design
- High-performance in a cost-effective package
- Rugged mechanical construction
- Optional linear encoder
- 80 models with travels from 50 mm to 1000 mm
- Vacuum and cleanroom versions available

PRO-LM Series

PRO-LM Series

- Improved second-generation design
- Rugged mechanical construction
- High-performance in a cost-effective package
- Direct-drive linear motor for ultra-precise motion
- 57 models with travels from 50 mm to 1500 mm
- Vacuum and cleanroom versions available

AGS15000

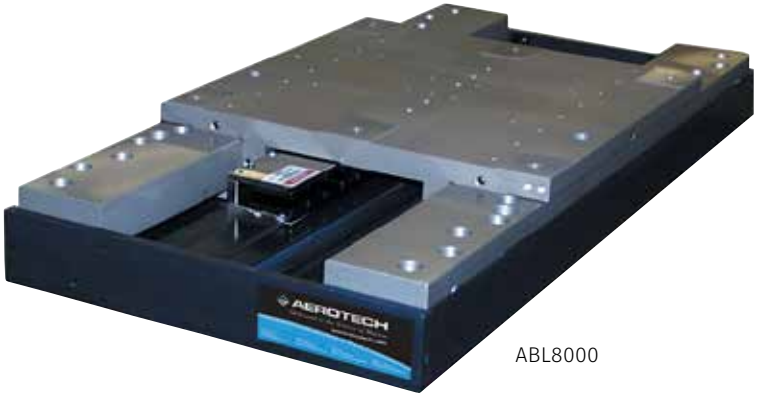
AGS Series

- Optimized design for precise contouring
- Velocity to 3 m/s and acceleration to 5 g
- High-power brushless linear servomotors for smooth motion
- Travels up to 1.5 m x 1.5 m
- Customizable Z and theta axes for flexible configurations
- Noncontact linear encoders
- Configurable cable management system allows for integration of fiber lasers, cameras, air lines, etc. for multiple applications

ABL1500XY on granite

ABL Series

- Exceptional geometric air-bearing performance
- Travels to 1200 mm
- Linear encoder or laser interferometer feedback
- Submicron accuracy
- Integrated XY and XYZ systems
- Non-cogging direct-drive motors



ABL8000

Planar Air-Bearing Stages

Planar$_{HDX}$

Planar$_{HDX}$

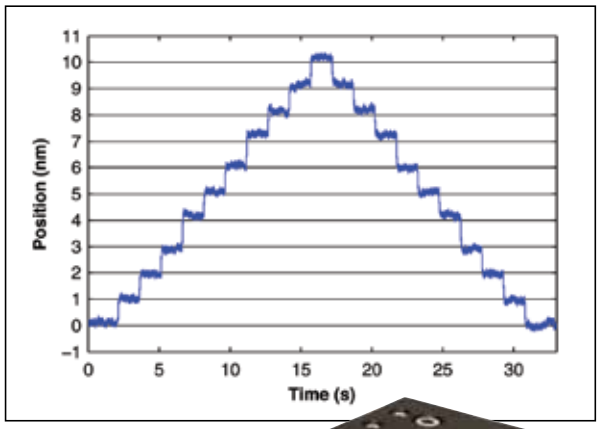
- Advanced silicon-carbide structure for high dynamics and ultra-precise motion performance
- Speeds to 1.5 m/s and accelerations to 5g
- Proprietary reaction-mass design enables fast turnaround and move-and-settle times
- Active and passive isolation system options
- Encoder or laser interferometer feedback
- Linear motors with improved thermal management
- Advanced control solutions offer enhanced throughput

Planar$_{HD}$

Planar$_{HD}$

- Maximize throughput with 2 m/s scan velocity and 5g acceleration
- Faster turnaround and minimized settling times
- Active yaw control
- Linear encoder or laser interferometer feedback
- Travel to 1.2 m x 1.2 m

Nanopositioners



ANT95-50-L-PLUS 1 nm step plot

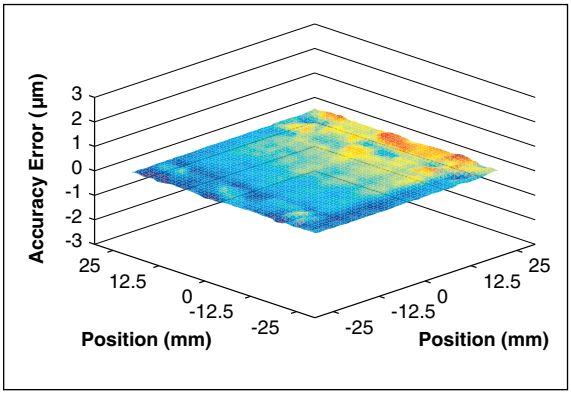
The ANT95-L series offers 25, 50, 75 and 100 mm travels

ANT95-L Single-Axis Linear Stage

- Noncontact, non-cogging, frictionless direct-drive – zero backlash or hysteresis
- High resolution (1 nm), repeatability (75 nm), and accuracy (250 nm)
- In-position stability of <1 nm
- Anti-creep crossed-roller bearings
- High dynamic performance
- Available in X, XY, XYZ, and many other combinations

ANT95-XY Dual-Axis Linear Stage

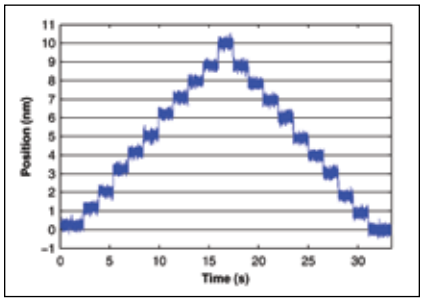
- Integrated low profile XY linear motor stage
- Noncontact, non-cogging, frictionless direct-drive – zero backlash or hysteresis
- High resolution (1 nm), repeatability (75 nm), and accuracy (250 nm) per axis
- In-position stability of <1 nm
- Anti-creep crossed-roller bearings
- High dynamic performance



ANT95-50-XY-ULTRA 2D system accuracy

The ANT95-XY series offers 25 x 25 mm or 50 x 50 mm travel

Nanopositioners



ANT130-060-L-PLUS 1 nm step plot

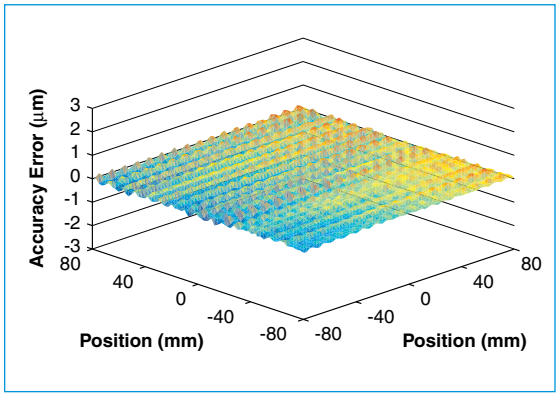
ANT130-L Single-Axis Linear Stage

- Noncontact, non-cogging, frictionless direct-drive – zero backlash or hysteresis
- High resolution (1 nm), repeatability (75 nm), and accuracy (250 nm)
- In-position stability of <1 nm
- Anti-creep crossed-roller bearings
- High dynamic performance
- Large selection – 4 different travel options

The ANT130-L series offers 35, 60, 110, or 160 mm travel

ANT130-XY Dual-Axis Linear Stage

- Integrated low profile XY linear motor stage
- Noncontact, non-cogging, frictionless direct-drive – zero backlash or hysteresis
- High resolution (1 nm), repeatability (75 nm), and accuracy (250 nm)
- In-position stability of <1 nm
- Anti-creep crossed-roller bearings
- High dynamic performance



ANT130-160-XY-ULTRA 2D system accuracy

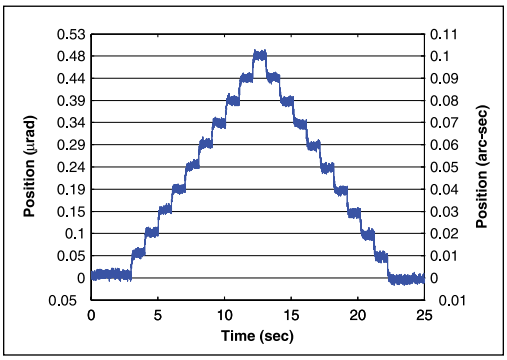
GOLDEN MOUSETRAP Best New Products AWARDS WINNER 2010

CONTROL ENGINEERING 2011 ENGINEERS' CHOICE AWARDS

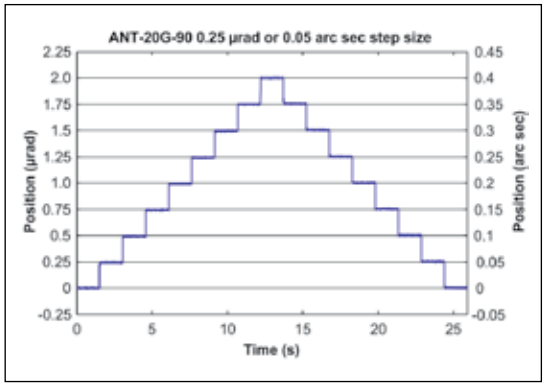
The ANT130-XY series offers 60 x 60, 110 x 110, or 160 x 160 mm travel

ANT95-R and ANT130-R Rotary Stages

- High resolution (0.01 arc sec)
- High performance in large travels
- Outstanding error motion specifications
- 0.005 arc-sec in-position stability
- 3 arc-sec accuracy
- 1.5 arc-sec bi-directional repeatability
- Multi-axis configurations



ANT95-R 0.01 arc-sec step plot



ANT-20G-90 0.05 arc-sec step plot

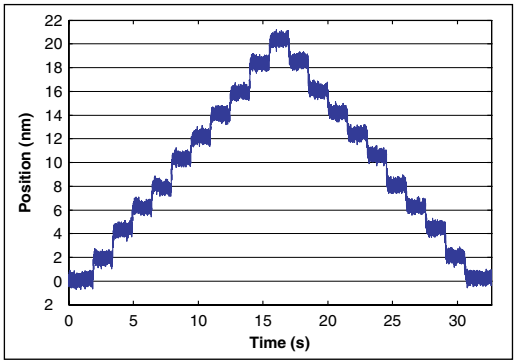
ANT-20G Goniometers

- Noncontact, non-cogging, frictionless direct-drive – zero backlash or hysteresis
- High speed (150° /s)
- High resolution (0.05 arc second)
- Excellent in-position stability
- Large 20° rotation angle
- Orthogonal mounting of two cradles provides rotation about the same point
- Compact design

Nanopositioners

ANT95-L-Z and ANT130-L-Z

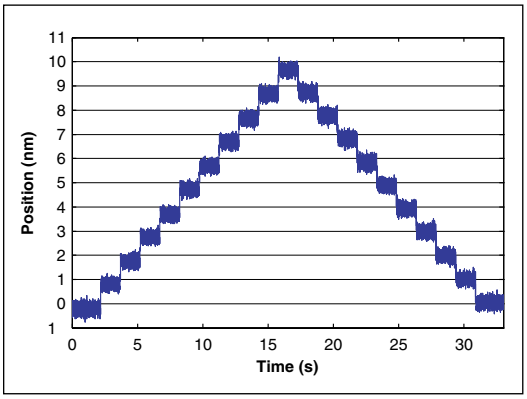
- Nanometer performance in a large travel format
- High resolution (2 nm), repeatability (75 nm), and accuracy (300 nm)
- In-position stability of <2 nm
- Anti-creep crossed-roller bearings
- High dynamic performance
- Pneumatic counterbalance is adjustable for customer-specific payload



ANT95-50-L-Z-PLUS 2 nm step plot

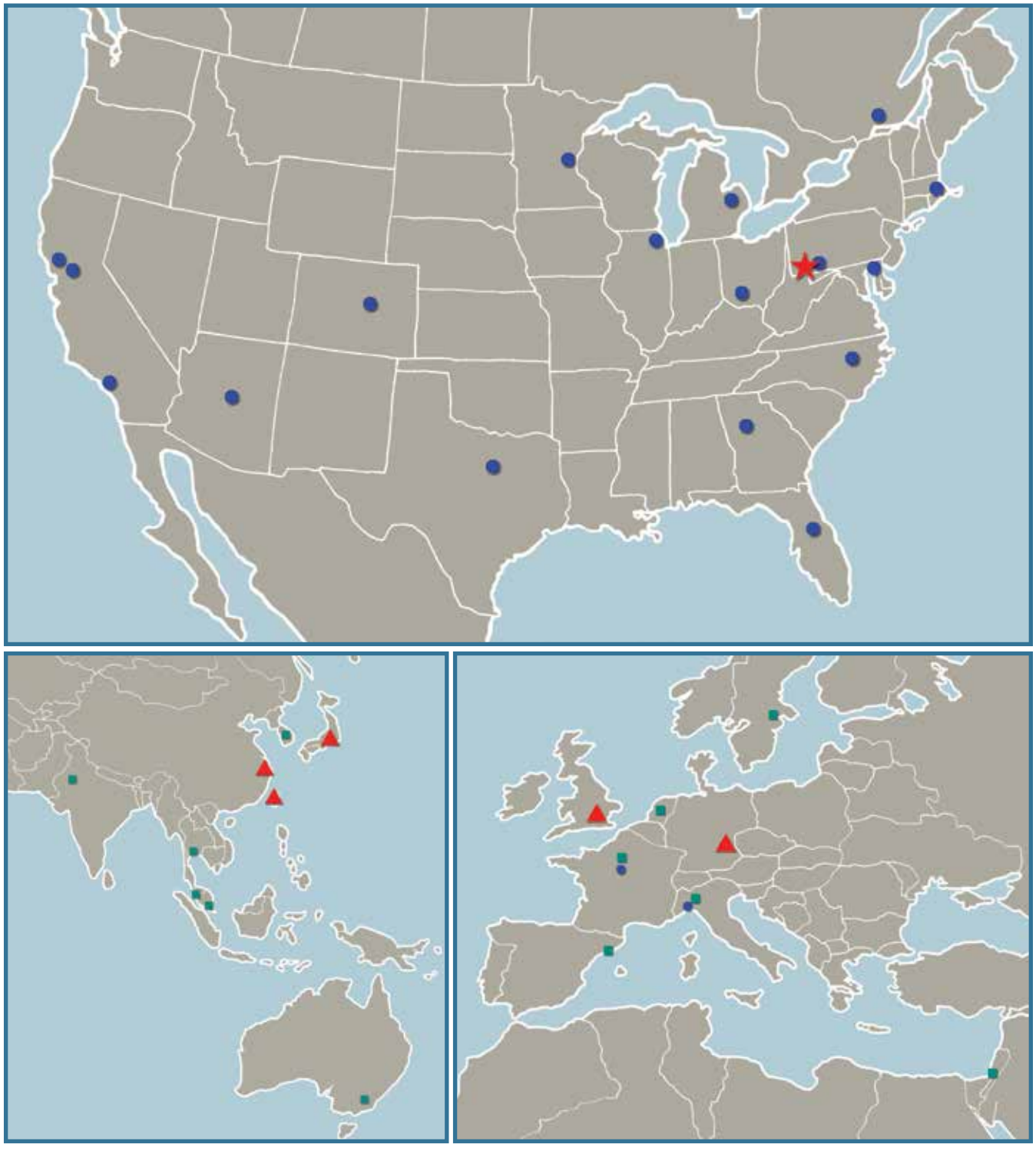
ANT95-3-V and ANT130-5-V

- Nanometer performance with either 3 or 5 mm travel
- In-position stability of <1 nm
- 200 nm accuracy



ANT95-3-V-PLUS 1 nm step plot

Aerotech's Worldwide Sales and Service Locations



★ - Aerotech Headquarters ● - Direct Field Sales Office ▲ - Aerotech Subsidiary ■ - Representative

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