Integrated Automation Solutions

Motion Control

aerotech.com
Aerotech’s
Advanced Automation Technologies:
40 years in the making... and going strong...

- Controls
- Software
- Amplifiers
- Motors

- PLC
- Fieldbus
- I/O
- Vision
- Peripherals
- Robotics
- Data Acquisition
Aerotech Integrated Automation Solutions

• High performance
• Easy to use
• Flexible
• Scalable
• Networked
• Lowest cost of ownership
• Advanced control technology
• Controls servo, piezo, voice coil, and stepper motor

Common Software Platform: Tools, Powerful Programming

Diagnostics
Autotune
PID Calculator

Develop your own applications with .NET, C#, VB.NET, C,

Award-Winning Controllers

Automation 3200
• PC-based
• 1 to 32 axes of coordinated motion
• Up to 32 tasks
• 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
• Retro-fit package for old controls
• Integrated PLC and Motion - MotionPAC

Ensemble™
• Stand-alone
• 1 to 10 axis controller
• Up to 4 tasks
• Versatile, cost-effective, coordinated motion
• PWM or linear drives (10-150 A peak)
• Drives brushless, linear, rotary, DC brush or stepper motors
• Desktop, rack mount or panel mount

www.aerotech.com
Configure Your Automation Solution with Aerotech

Environment, Calculators, Diagnostics

Soloist™
- Stand-alone
- Network up to 1024 single axes
- Up to 4 tasks
- Elegant, economical, versatile controller
- PWM or linear drives (10-150 A peak)
- Drives brushless, linear, rotary, DC brush or stepper motors

Piezo Controls
- Network up to 32
- Coordinated motion with servo, and stepper motor stages
- Available in desktop or rackmount configuration
- Powered by Automation 3200 motion controller

Linear and Rotary Servomotors/Accessories

- EtherCAT™
- EtherCAT™
- PROFINET
- Modbus®/TCP
- USB
- GPIB

LabVIEW®, Tango, AeroBasic™ or PLC languages

Fieldbus and Network Connectivity

- EtherCAT™
- EtherCAT™
- Ethernet TCP/IP
- Ethernet TCP/IP
- USB
- GPIB

Custom Controls, Drives and Motors

- PLC
- Industrial PC
- Custom Motors
- Fieldbus - I/O

World Headquarters, Aerotech Inc., U.S.A. 412-963-7470 • United Kingdom +44 (0)1256 855055 • Germany +49 (0)911 967 9370 • Japan +81 (0)50 5830 6821 • Taiwan +886 (0)2 8751 6690 • China+86 (21) 3319 7715 • France +33 1 64 93 58 67
Scalable Automation Control Software for Simple Applications and the Power User

Motion Composer: Use the same Aerotech software with the A3200, Ensemble, or Soloist

- Configuration Manager to organize your applications
- Calculators for quick and easy setup
- Extensive diagnostics for commissioning
- Integrated Development Environment for fast development
- Data Acquisition and Analysis Tools for increasing performance
- Fully compliant .NET 2.0 shortens the development cycle
Integrated Configuration Manager for Easy Setup

- Standard Windows® menus
- See all the controllers on the network
- Work with this controller
- Network Explorer for project management
- File space on the controller
- Extensive calculators for system setup
- Compare parameter files
- Tool tips
- Standard motion toolbars
- Configurable workspace with your preferences
- Context sensitive integrated help
- Hyperlink to associated subjects
Calculators for Quick and Easy Setup

- Easily switch axis to be configured
- Select your motor or add a custom motor
- System knows all parameters of Aerotech components
- Select amplifier type
- Directly enter any parameter values here
- Summary of default, current and new values for all parameters

Current loop calculator

PID gain calculator

Configure feedback for user units
Extensive Diagnostics for all System Signals and Variables Shortens Debug and Startup Time

- Control all axes at once
- Multiple tabs for organized programming
- View task status as needed
- Watch any variables as the program runs
- Pop-up error reporting
- Compiler output screen
- System toolbar for system control
- Axis toolbar for control of each axis
- Standard toolbar for program control
- Issue immediate commands without operator interface open
- Dockable windows for custom work environment
- Configurable to see only the information you want
- Real-time readout of system state variables
- Real-time access to system signals
- Real-time reporting of all faults
- Real-time system information

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Advanced Diagnostic and Tuning Capabilities Minimize Startup Time and Allow Easy Optimization of Motion

- Current and recommended gains pop up after each run
- Save plots for future reference
- Use sinusoidal sweep or white noise method
- Input amplitude and frequency range for test
- Select desired system bandwidth and phase margin
- Scope, tuning and data collection fully integrated with controller
- Automatic calculation of PID-FF gains
Use Encoder Tuning Tool to Increase System Accuracy

One click tuning

Fully integrated with controller

Optimally calculates gain and phase of amplified sine encoder channels in seconds

Actual encoder performance

Graphical display of the Lissajous plot to optimize the encoder signal
Loop Transmission is a Tuning and Diagnostic Utility that Greatly Enhances System Performance

- Frequency response between any two system state variables*
- Open or closed loop response
- Analyze position loop, velocity loop or current loop
- Cross-axis loop transmission to optimize multi-axis performance*
- Graphical loop shaping — add filters or change gain by dragging the gain curve, and the filter coefficients and PID gains are calculated automatically
- Automatic calculation of gain margin
- Identify resonances and use filters
- Calculator and loop shaping to increase performance
- Automatic calculation of phase margin
- System frequency response or Bode plot

*Coming Soon

www.aerotech.com
Fully Integrated Digital Filter Calculator Makes Performance Enhancements Easy

- **Select your filter type:** low pass, high pass, notch, resonant, lead/lag
- **Axis selection:** Add up to eight filters per axis
- **Configure filters for your application by specifying frequency, depth and width:** Discrete time gains are automatically calculated and stored in the parameter file
- **Cursor control to read out gain and phase:** Composite frequency response of all filters
- **Store all parameters in the parameter file**
Integrated I/O Panel for Debug, Commissioning or Operations

- View I/O axis information and program at the same time
- Monitor digital I/O control
- Monitor analog I/O
- Set digital I/O during test and commissioning
- Use the I/O panel during programming to test as you go
- Tool tip provides physical connector and pin on the drive to easily associate electrical wiring with software variables
- Set analog I/O during commissioning for easy testing
Integrated Development Environment Shortens Development Time

- Hide the axis manager while programming to see more code
- Visual Studio®-like project management for advanced programming
- Powerful IntelliSense® capability
- Insert breakpoints to debug program
- Low learning curve with strict implementation of .NET naming conventions
- Detailed error explanation in error list

- Minimize development time with debug features, break point, step in and step over
- Full diagnostic instrumentation while debugging
- Watch window shows variable values for easy debugging
- Link to help file for description of error
Create Reusable Modules with AeroBasic™

Create reusable code with libraries and `#include` files

Write easy-to-read and maintainable code by using `#define` (rather than numeric constants)

Real-time code environment

Advanced programming techniques result in code that is easy to read, simple to maintain and reusable for other projects

Protect intellectual property by using a library; permit or deny end users access to source code

Built-in software security key for OEMs
Create Easy to Maintain Code with AeroBasic™

User defined variable types allow an object-oriented approach to system design

Advanced variable types such as arrays and strings allow for more advanced program design

Use structures to define your own data types

Keeping all motion code in one function creates modularity, which brings products to market faster and reduces maintenance cost

Variable initialization reduces code size and increases readability for multiple developers

Memory management is done by the operating system

Standard program flow: while/wend for/next repeat if/then/else
Integrated Automation: MotionPAC

- 30% to 50% reduction in development time
- High-performance motion fully integrated with standard PLC environment
- Easy-to-use diagnostics and tools
- Standards & Flexibility: IEC 61131-3, .NET, PLCopen, PC-based

Program in IEC 61131-3: LD, FBD, ST

- Define hardware
- Online mode displays all Tag values
- Create libraries
- Axis manager
- Standard LD
- Combine LD and FBD in the same program
- Tag database
- LD, FBD or ST programs
- Completely integrated motion blocks
Integrated Automation: MotionPAC – PLC and Motion

MotionPAC
- IEC 61131-3
- PLCopen
- Aerotech motion blocks
- Axis manager
- Extensive development & debug environment
- Simulate program

Motion Composer
- Axis manager
- Low-level motion diagnostics
- Motion programming
- Advanced control algorithms

Beckhoff Wago
- Data acquisition synchronized with motion & PLC
- High-speed registration
- Position Synchronized Output
- Machine interlocks
- Fieldbus I/O

HMI
- Program selection and run
- Jog panel
- Machine control
- Customizable buttons
- Axis manager

Central Machine Tag Database
- Tags available in all applications by name
- Define both local or global machine Tags
- Define Tags in I/O definition, ST, LD, FBD or motion program

Scope
- Signal capture & analysis
- Autotuning
- Loop transmission
- Encoder tuning
- Advanced controls
Use Tags in Operator Interface by Name

View CNC code running at same time as PLC code

Use shared Tags defined in MotionPAC by name in a button action

Use shared Tags by name in program called by a button click
Standard PLC Functions: IEC 61131-3

Ladder Diagram
- VALUE
- TRUE
- FALSE
- COMMENT
- CONNECTOR
- JUMP
- LABEL
- RETURN
- CONTACT (NO, NC)
- COIL
- LEFT POWERRAIL
- RIGHT POWERRAIL

Function Blocks
- CTD
- CTU
- CTUD
- F_TRIG
- R_TRIG
- RS
- SR
- TOF
- TOF_R
- TON
- TON_R
- TP
- TP_R

Motion Blocks (Partial List)
- MoveAbsolute
- MoveRelative
- MoveSuperimposed
- MoveVelocity
- Home
- Stop
- PositionProfile
- MoveContinuous
- Halt
- CamIn/CamOut
- CamTableSelect
- GearInPos
- GearIn/GearOut
- Phasing

Administrative Motion Blocks (Partial List)
- ReadStatus
- ReadAxisError
- ReadParameter
- WriteParameter
- ReadActualPosition
- AbortTrigger
- ReadDigitalInput
- ReadDigitalOutput
- WriteDigitalOutput
- SetPosition

Functions (Partial List)
- ABS
- ACOS
- B_BCD_TO_DINT
- B_BCD_TO_INT
- DELETE
- DINT_TO_BOOL
- EXP
- EXPT
- FIND
- GE
- GE_STRING
- INT_TO_BOOL
- INT_TO_BYTE
- INT_TO_DINT
- INT_TO_DWORD
- LE
- LE_TRING
- LEFT
- LEN
- MULTIME
- NE
- OR
- REAL_TO_BOOL
- SEL_TO_BOOL
- SEL_TO_BYTE
- TRUNC_SINT
- UDINT_TO_BOOL
One I/O and Data Dictionary for the Machine

- I/O available in all applications: scope, configurator, MotionPAC (PLC) and Motion Composer
- Drive I/O connected to system
- Fieldbus I/O connected to the system
- Easily map I/O to program Tags
- Memory management automatically done by the MotionPAC
- I/O defined in one place
Use Scope to Plot any Motion, PLC, I/O, Variable or Tag

All information in Global Tag database available for real time plotting and analysis with all motion variables.
SDK: Software Development Kit

- Easy to use
- Faster development
- Lower maintenance cost

Use the Aerotech standard GUI...
...or build a custom interface for your application

- C#
- VB.NET®
- Managed C++
- LabVIEW® (VIs provided)
- C Library
- EPICS
.NET Library

- High-end motion with a custom GUI
- Use the best language for the application
- Fully functional libraries for each language

All Aerotech applications are written using the .NET library. Aerotech provides customers with the same tools used at Aerotech.

Take Advantage of:

- .NET Framework 2.0
  - Generics
  - Enumerations
  - Indexers
  - Events
  - Exceptions

- Object Model
  - Well-organized structure with two main classes: network and controllers
  - Common features are higher in the hierarchy
  - Minimal code required to accomplish the task at hand

- Libraries Include:
  - Initialization functions
  - Global data functions
  - Motion functions
  - Error handling
  - Status and position functions
  - Analog and digital I/O functions
  - Parameter functions
  - Run CNC program functions
  - Utility functions
  - Get and set variable functions

Object Model

Legend
- Class
- Collection

Controller
- Configuration
- ...
- ConnectedController
- RootCommands
  - <Specific Category>
  - AxesRootCommand
- <Specific Category>
- ControlCenter
  - DiagPacketPoller
  - TaskStatesPoller
- Data
  - Configuration
- Information
  - Axes
  - AxInfo
  - ControllerVersion
- Variables

ControllerParameters
- <Specific Category>
- Axes
  - <Specific Category>
- AxesParameters
  - <Specific Category>
- Tasks
  - <Specific Category>
- TaskParameters
  - <Specific Category>
- TasksCollection
  - Task
  - Program
  - ProgramDebug
  - Callbacks
Motion Designer: Graphical Trajectory Generation and Data Analysis

Create and modify multi-axis trajectories using predefined building blocks to provide rapid motion prototyping.

Perform data analysis such as FFT, max, min, average, rms and standard deviation from an existing trajectory for diagnosing system performance.

Add standard filter types: notch, resonant, low pass and high pass.

Enter standard filter frequency parameters.

Digital filter coefficients are automatically calculated.

Import existing position, velocity or acceleration data.

Apply filters to shape the trajectory frequency content.

View the composite filter before applying to the trajectory.

Cursor control.
• Minimize programming time
• Import actual data
• Import from Excel or MATLAB®

Applications
• Dynamic environment simulation
• Sensor or component testing
• Gyros or accelerometers; tracking or beam-steering gimbals
• Crash sensors and roll-over sensors

Automatic AeroBasic™ program generation for all controllers

Create periodic motion

Project tree for simple organization

Trajectory properties (e.g., user units)

Automatically calculates missing state information (e.g., acceleration, velocity or position)

Point-to-point moves

Overlay multiple trials for easy comparison

Easily modify an existing trajectory

Rapid motion programming

Applications
• Dynamic environment simulation
• Sensor or component testing
• Gyros or accelerometers; tracking or beam-steering gimbals
• Crash sensors and roll-over sensors
Aerotech Motion Simulator – The Integrated, Easy to Use, Graphical Trajectory Generation, Data Analysis and Enhanced Machine Performance Toolkit.

Aerotech’s Motion Simulator software 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 1-3 axis motion simulations. The GUI provides a user interface and programming environment that requires no third-party development software.

Key Features:

- User-friendly Windows®-based graphical user interface
- Trajectory tracking from Ethernet, analog or Windows® program inputs
- Iterative Learning minimizes position error
- Overlap multiple runs of a trajectory to easily see how program changes modify the motion
- Perform data analysis such as FFT, max, min, average, rms and standard deviation from an existing trajectory for diagnosing system performance
- Data input file formats include Excel, CSV or MATLAB®; Motion Simulator can calculate the missing state variables

Motion Simulator – GUI

- Operate 1,2,3 axis motion simulators
- Frequency response mode allows input sine sweep and UUT performance tests on customer device
- Harmonic Cancellation optimizes motion position errors generated by sinusoidal motion
Motion Designer

Program

Frequency Response

Data Analysis

Track screen allows external signal selection for tracking
CADFusion™

• Easily imports vector-based drawing files and produces G-code motion programs
• Interactive canvas allows easy editing and creation of new shapes and text
• Automatic and manual shape re-ordering options allow for optimal tool and processing paths
• Export to RS-274D G-code format
• Allows user-defined initialization, process shutdown, and shuttering commands (tool on/off)
• Offers seamless use of Aerotech’s powerful controller features such as PSO (Position Synchronized Output)

Generate Motion Programs Directly From Your CAD Drawing
Simulation API

- Support for Coppelia Robotics virtual robot experimentation platform (V-REP)
- Full system modeling capability
- Visualization and selection of coordinate systems for multi-DOF systems like hexapods
- Pre-configured models connect directly to Aerotech’s A3200 motion controller
- Import custom objects as 3D mesh files
- Supports collision detection between all elements in the environment
- Control grippers and vacuum pickup devices with Aerotech I/O
Operator Interface

- Use the Aerotech Operator Interface (OI) for fast deployment
- Customize the OI to suit the application
- User customizable buttons that can execute standard G-code and AeroBasic™
- Quickly build a new interface in the OI builder*
- Import and export to Visual Studio® for flexibility*

*Coming Soon
Advanced Software Architecture

- Layered for flexibility
- Customizable at many layers
- Most cost-effective solution
Digital Automation Platform

• Higher throughput due to high performance control, network and high-power drives
• Higher accuracy and repeatability due to all digital drives and advanced servo algorithms
• Faster startup and changeover results from fully integrated motion platform, easy-to-use setup tools and extensive diagnostics
• Lower startup and life-cycle cost due to less components and reduced engineering
• Higher reliability due to fewer components
• Simplified integration

Distributed Motion Control
• Motion trajectory generation and synchronization are centralized at the PC
• Motion execution is decentralized at the drives
• A3200 operates on any standard desktop or industrial PC
• Servo loops are closed on the drive

Npaq® 6-Axis High Performance Drive Rack
The Intelligent 32-Axis Motion, Vision, PLC, Robotics and I/O Platform

- Easily installed digital drives
- FireWire® (IEEE-1394) industry standard, high-performance motion bus

Any Brush, Brushless or Stepper Motor with any Drive

Digital Drive Features

- PWM or linear (10 A to 150 A peak)
- Integrated 10/100 Base-T Ethernet
- Encoder, resolver or inductosyn feedback
- Onboard x65536 encoder multiplication
- 20 kHz position, velocity and current-loop sample rate
- Integral power supply
- Sinusoidal commutation
- Local I/O ports

Easily integrates with Keyence LK-G Series Laser Displacement Sensors

Nmark SSaM Ndrive CL Ndrive HLe Ndrive HPe Ndrive ML Ndrive CP

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Ensemble®

Stand-Alone Multi-Axis Automation Controller

• Easy to use
• Powerful architecture
• Distributed control
• Network ready

6-Axis Stand-Alone, Rack Mount or Desktop Plus Three Axes
Applications

- Semiconductor
- Medical
- Test and Inspection
- Packaging

Capability

- Point-to-Point
- Linear and Circular Interpolation
- Electronic Gearing
- Velocity Profiling
- Gantry

Software, Controls, Drives and I/O... All in One Package
10-Axis, Stand-Alone, All Digital, Panel-Mount Controllers

AeroNet
from 10 to 150 A peak

Efficient motion programming with IDE

Easily integrates with Keyence LK-G Series Laser Displacement Sensors

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Soloist®

Stand-Alone Single-Axis Automation Controller

• Easy to use
• Scalable
• Ethernet/USB connectivity
Software, Controls, Drives and I/O in One Compact Package
from 10 to 150 A peak

Connect, program or monitor locally or remotely

LAN/WAN/Internet up to 1024 on one network

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Controller and Drive Technology

Ndrive® MP
Ensemble® MP
Soloist® MP

Width: 41.1 mm
Height: 141.2 mm

LED Status Indicators
FireWire®
(IEEE-1394)
(J101, J102)

Motor Feedback Connector (J103)
10-80 VDC Bus Voltage Input
Motor Output
10-80 VDC, 10 Apk
24-80 VDC, 2 A Max Logic Power Input (TB103, Bottom)

Emergency Stop Sense Input (TB101, Top)
Second Encoder Interface (J201)
Brake Relay (TB201)
Eight Opto-Isolated Outputs, Common Sink or Common Source (User Defined) (TB202)
One 12-Bit Analog Input and One 16-Bit Analog Output (TB202)
Eight Opto-Isolated Inputs, Common Sink or Common Source (User Defined) (TB203)

Ndrive® CP
Ensemble® CP
Soloist® CP

Width: 63.5 mm
Height: 198.2 mm

LED Status Indicators
Ethernet TCP/IP (J101, J102)
Motor Feedback Connector (J103)
Emergency Stop Sense Input (TB101)
Auxiliary I/O (J104)

Two 16-Bit Analog Inputs, One Analog Output (TB201)
Eight Opto-Isolated Outputs, Common Sink or Common Source (User Defined) (TB202)
Eight Opto-Isolated Outputs, Common Sink or Common Source (User Defined) (TB203)
Seven-240 VAC Single-Phase Power Input
Motor Output
10-320 VDC, 10-30 Apk
Control Supply (Bottom)
Brake Relay (TB206)

www.aerotech.com
Model shown is 10 to 30 amps peak with I/O expansion
Controller and Drive Technology

Ndrive® HPe150
Ensemble® HPe150
Soloist® HPe150

Width: 229.7 mm
Height: 406.1 mm

Ndrive® ML
Ensemble® ML
Soloist® ML

Width: 41.1 mm
Height: 141.2 mm

Line Supply
Motor Power
External Shunt
Control Supply
Auxiliary I/O
RS-232
ESTOP
Motor Feedback

Relay
Resolver
USB
Brake Power
Ethernet

Additional Digital and Analog I/O

Eight Opto-Isolated Outputs, Common Sink or Common Source (User Defined) (TB204)

Motor Output
±40 VDC, 10 Apk

24 VDC, 2 A Max Logic Power Input (TB103, Bottom)

Emergency Stop Sense Input (TB101, Top)

Brake Relay (TB201)

One 12-Bit Analog Input and One 16-Bit Analog Output (TB202)

Eight Opto-Isolated Inputs, Common Sink or Common Source (User Defined) (TB203)

Motor Feedback Connector (J201)

Ethernet (IEEE-1394) (J101, J102)

LED Status Indicators

Motor Feedback Connector (J103)

±40 VDC Bus Voltage Input

Eight Opto-Isolated Inputs, Common Sink or Common Source (User Defined) (TB203)
**Linear Drive Advantages**
- Ultra-smooth motion during reversals
- Superior in-position stability
- Integrated with controls

- No switching noise
- No dead band
- Low EMI

**Applications**
- Nondestructive testing
- Stencil cutting
- Any small move, or sinusoidal movements

- Very slow velocity applications
- Stent manufacturing
- Target tracking
- Piezo stages

**HEX RC**

**Product Features - Standard**
- 4U tall rack mount
- PC
  - Intel i8, 4 Core, 8 GB memory
  - Windows 7 64-bit
  - 120 GB SSD drive
- Drives
  - 6 NDriveMP10 (2 have I/O option)
  - TTL (-FC1, -FC3) and MXU (-FC2, -FC4) options
- I/O
  - Digital I/O - 16 in, 16 out - opto-isolated
  - Analog Inputs - 8, ±10 V 12-bit differential
  - Analog Outputs - 2, ±5 V, 16-bit

**Ndrive® HLe**
**Ensemble® HLe**
**Soloist® HLe**

- Width: 206.9 mm
- Height: 234.3 mm

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Controller and Drive Technology

**Nmark™ CLS**
- Width: 90.5 mm
- Height: 210.8 mm

**Nstep**
- Width: 49.2 mm
- Height: 161.8 mm

- One Input and Output per Axis and Sixteen Additional I/O Points
- Reset LED
- Enabled LEDs Axis 3 and 4
- Power LED
- Amplifier Interface Axis 1
- Amplifier Interface Axis 3
- Amplifier Interface Axis 2
- Amplifier Interface Axis 4

- Encoder Input Axis 1
- Encoder Input Axis 3
- Encoder Input Axis 4

- Analog I/O
- Laser Interface
- Opto-Isolated I/O
- FireWire®
- Laser Input
- Polarity Switch
- 3-Axis Galvo Motor and Feedback
- 3-Axis Servo Feedback Input (Not Shown in Current View)
Controller and Drive Technology

Npaq®
6 Axis or Less
Width: 436.7 mm
Height: 132.0 mm
Laser Feedback (Optional)
Power Switch/ Circuit Breaker
Resolver Inputs (Optional)
Analog I/O (Optional)
Emergency Stop (Optional)
AC Power Input
Motor Output
Encoder Feedback
Communication Channel Numbers
User I/O
FireWire®
Ethernet (Optional)

Npaq® MR/Epaq MR
8 Axis or Less
Width: 436.7 mm
Height: 132.0 mm
Power Switch
Joystick
Analog Connection
FireWire®
Communication Channel
Numbers
User I/O
Ethernet (Optional)
FireWire®
Encoder
Motor
115 VAC or 220 VAC
**Npaq® and Epaq Rack Mount or Desktop Solutions in One Box Minimize Wiring**

**Ensemble® Epaq**
- 5 Axis or Less
  - Width: 431.8 mm
  - Height: 177.8 mm
- Directional Keypad
- LCD Screen
- ESTOP Button (Optional)

**Ensemble® LAB**
- 4 Axis or Less
  - Width: 370.2 mm
  - Height: 98.4 mm
- Touch Screen Interface
- Numeric Keypad
- Directional Keypad
- Power Switch

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## Standard Control Capabilities

<table>
<thead>
<tr>
<th><strong>Point-to-Point Motion</strong></th>
<th>Basic independent axis positioning with programmable accel/decel and feedrate.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acceleration Limiting</strong></td>
<td>Anticipate sharp corners and small radius arcs and automatically decelerate as needed.</td>
</tr>
<tr>
<td><strong>Coordinated Motion</strong></td>
<td>Linear and circular motions are supported in all languages.</td>
</tr>
</tbody>
</table>

- **Arbitrary Path Generation (PVT)**: Specify discrete position, velocity and time and the controller will interpolate to create a smooth, contiguous path.

- **Electronic Gearing**: Electronically control one axis as a simple ratio or as a complex function of another axis; fire I/O in real time during a move.

- **On the Fly End-Point Modification**: Modify the endpoint during execution of the motion profile.

- **Cutter Compensation**: Also known as tool radius compensation, this feature automatically adjusts the path to allow for the radius of a cutting tool.

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

- **Velocity Profiling**: Maintains a constant vector velocity along the programmed path.
Aerotech controllers offer the broadest array of programming interfaces and core motion capabilities of any automation system available today. Aerotech controllers have the programming flexibility and capability to meet the requirements of the most demanding motion applications of OEMs and end-users alike.

**Seven Segment Acceleration**
Specify the acceleration profile in seven segments, providing precise control over system motion.

**Velocity Blending**
The velocity changes to the next velocity command, acceleration limited, without stopping.

**Fast Position Capture**
Store positions based on the transition of a digital input, allowing close correlation of axis positions to external events.

**Retrace**
Retrace a path block by block.

**Intra-Block Retrace**
Retrace a path inside a block.

**High-Speed Registration**
High-speed registration to trigger motion is useful in packaging and labeling.

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

**Kinematics**
Execute complex inverse kinematic equations within the flow of the trajectory generation.

**Analog Power Control**
Adjust the setting of an analog output in relationship to the vector speed of two axes to permit the automatic regulation of laser power or material dispensing processes.
Standard Control Capabilities

**Motor Control**
All controllers operate brush, brushless or stepper motors in any combination.

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

**Axis Calibration**
Compensate for repeatable mechanical errors in a positioning system.

**Sinusoidal Commutation**
Brushless motors produce smoothest motion when sinusoidally commutated, eliminating the need for multiple transducers and reducing cabling.

**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.

**Quadrature Encoder**
Use a standard A,B quadrature encoder, incremental or absolute.

**Analog Feedback**
For high resolution, short travel applications, linear drives accept analog inputs from analog sensors.

**Resolver/Inductosyn**
Programmable carrier frequencies make resolvers/inductosyns easy to integrate.
Laser Interferometer: Systems requiring ultra-high resolution and feedback stability use interferometer feedback.

Encoder: Systems requiring high resolution use a 1 Vpp encoder with Aerotech multiplier, up to 65,536 and 2 MHz input frequency.

Tachometer: For dual feedback systems use tach for velocity control and encoder for position control.

PIDFF: PID digital control loop with feedforward for velocity, acceleration and friction.

Safe Zones: Safe zones can be set up on multi-axis systems to protect against crashes.

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

Limits: Set up hard limits and soft limits for maximum safety and flexibility.

Spindle Control: Spindle commands use standard m-codes.

CAM Profiling: Electronically command one axis position as a function of another axis with a CAM table and fire I/O during the move.
Advanced Control: Harmonic Cancellation

- Reduce position error on periodic trajectories
- Reject periodic disturbances
- Built-in setup wizards
- Adapts to magnitude and frequency of error source

Reduce Position Error

Position error without harmonic cancellation

Continuously adapts and tracks sinusoids

Position error with harmonic cancellation

10 Hz Command; ± 1 mm

Applications

- Machining
- Spindle Control
- Cogging Reduction
- EDM/ECM
- MEMS Sensor Testing
- R0 Wafer Inspection

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Advanced Control: Iterative Learning Control

- Repeating move sequences can be learned and optimized
- Reduce following error
- Increase dynamic accuracy
- Increase production rates

Applications
- Stencil Cutting
- Stent Cutting
- Sensor Testing
- Micromachining
Advanced Control: Enhanced Throughput Module (ETM)

• Multi-axis feedforward capability
• Faster settling time
• Increase rate stability

Applications
• Pick and Place Machines
• Semiconductor Inspection
• Genome Sequencing
Advanced Control: Directional Gain Scheduling

- Decrease settle time
- Increase in-position stability

System automatically adjusts gain based on error motion during settling.
Advanced Control: Gantry Control

• Both spars are programmed and commanded as a single axis
• Easy homing
• Marker offset for high accuracy
• Orthogonality correction

Gantry Modes
• Current Synchronization
• Position Synchronization

Gantry Configuration
• 2 Motors, 2 Encoders
• 2 Motors, 1 Encoder
• 1 Motor, 1 Encoder
Advanced Friction Model

Friction Compensation Results

High speed, high accelerations and minimal position error achieved with feedforward additive force
Advanced Control: EasyTune/EasySetup

• Automatically tune servo, and piezo axes
• Hands-off! EasyTune requires no user input or controls knowledge
• Set a custom performance target – improves throughput and system stability
Open architecture, PC-based robot controller for three-axis (X/Y/Z) Delta robots. Includes a pre-configured installation of Aerotech's A3200 automation platform with robot specific programming extensions, NEMA 32 frame size motors, drives, and cables. Key system features include:

**Delta Robot Control**

- Industrial panel-mount PC with solid-state disk drive
- Teach mode with user defined number of points
- Synchronization with moving material
- Target position command queue of user defined depth
- Real time simultaneous display of tool and work point coordinates
- G code and AeroBasic motion command syntax
- Control up to 20 additional axes
- Optional IEC 61131-3 PLC interface with support for PLCopen and .NET
- Servomotor with absolute feedback device and brake
- Ndrive CP10 drives
- 5 meter long motor power and feedback cables
Advanced Control: Command Shaping

- Increase throughput
- Faster settle time at the work point
- No additional sensors required
- Reduced vibration in point-to-point moves
- Easy tuning

Position error at work point to 30 mm step move

Applications
- Pick and Place Machines
- Semiconductor Inspection
- Genome Sequencing
Advanced Control: Position Synchronized Output (PSO)

- Increase throughput
- Higher accuracy
- 1-, 2- or 3-axis PSO
- Configurable command pulse train

- Use to Trigger
  - Laser firing
  - Camera capture
  - Data acquisition
  - Nondestructive test triggering

---

High Accuracy Firing Based on Actual Calibrated Encoder Counts

**Array-Based Firing**
- PSO fire points are defined in an array based on calibrated position
- Pulse train specified with absolute or incremental positions
- Variable pulse width
- Specify pulse lead, pulse and pulse tail for precise energy delivery

**Windowing**
- Output pulses are constrained inside a user-defined window with the first pulse relative to the edge of the window
- Excellent when the processing of a part requires the axes to move beyond the part for settling or direction reversal in applications such as flat-panel manufacturing or fuel-injector drilling

**Fixed Distance Firing**
- Single- or multiple-pulse output as a function of up to 3 axes' position feedback
- Minimizes heat-affected zone in welding, cutting and drilling
- Outstanding for stent manufacturing, hermetic welding and drilling holes in turbine blades
Advanced Control: Laser Marking Nmark® CLS (Closed-Loop Scanner)

- Expand scanner field-of-view without sacrificing effective pixel resolution
- Mark long vectors with one continuous pass
- Draw large-scale graphics without stitching multiple exposures
- Mark on a tube or other irregularly shaped object without manually repositioning
- Single programming environment

Directly Synchronize Scanhead and Servo Motion for Ultimate Flexibility in Marking Applications

- Dynamic field-of-view movement allows marking of non-repetitive patterns over large areas, greatly expanding the scanner operating envelope
- Continuous marking of long objects through combined servo and scanner motion eliminates line breaks that can occur when stitching together adjacent marking fields

for both scanner and servo axes minimizes application complexity
- Eliminate angular errors
- Scanner programmed with standard RS-274 G code
- Laser firing based on real-time scanner position

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## AGV Specifications

<table>
<thead>
<tr>
<th>Mechanical Specifications</th>
<th>AGV-10</th>
<th>AGV-14</th>
<th>AGV-20</th>
<th>AGV-14HP</th>
<th>AGV-20HP</th>
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</thead>
<tbody>
<tr>
<td>Beam Aperture</td>
<td>10 mm</td>
<td>14 mm</td>
<td>20 mm</td>
<td>14 mm</td>
<td>20 mm</td>
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<td>Resolution</td>
<td>12 µrad</td>
<td>0.007 µrad</td>
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<td></td>
<td></td>
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<tr>
<td>Marking Speed</td>
<td>3 m/s</td>
<td>2.5 m/s</td>
<td>1.5 m/s</td>
<td>2.5 m/s</td>
<td>1.5 m/s</td>
</tr>
<tr>
<td>Positioning Speed</td>
<td>12 m/s</td>
<td>9.5 m/s</td>
<td>4.5 m/s</td>
<td>9.5 m/s</td>
<td>4.5 m/s</td>
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<tr>
<td>Writing Speed</td>
<td>900 cps</td>
<td>700 cps</td>
<td>400 cps</td>
<td>700 cps</td>
<td>400 cps</td>
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<tr>
<td>Positioning Resolution</td>
<td>2 µm</td>
<td>1.1 nm</td>
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<td></td>
<td></td>
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<tr>
<td>Positioning Repeatability</td>
<td>2.4 µm</td>
<td>2 µm</td>
<td>2 µm</td>
<td>0.32 µm</td>
<td></td>
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<tr>
<td>Positioning Accuracy</td>
<td>&lt;800 µm [standard]</td>
<td>&lt;30 µm [standard]</td>
<td>&lt;50 µm [-PLUS option]</td>
<td>&lt;10 µm [-PLUS option]</td>
<td></td>
</tr>
</tbody>
</table>

## AGV Galvanometer

- Optical feedback device offers outstanding thermal stability
- Industry-best resolution of >24 bits when used with Aerotech’s Nmark CLS controller
- Wide range of apertures and focal lengths
- Many choices of mirror surface treatments for a variety of laser wavelengths

## Vector Applications
- Cutting
- Welding
- Sealing
- Ablation
- Marking

## Graphic Applications*
- Bar Code
- Serialization
- Engraving
- Character Scribing

*Coming Soon

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World Headquarters, Aerotech Inc., U.S.A. 412-963-7470 • United Kingdom  +44 (0)1256 855055 • Germany  +49 (0)911 967 9370 • Japan  +81 (0)50 5830 6821 • Taiwan  +886 (0)2 8751 6690 • China  +86 (21) 3319 7715 • France  +33 1 64 93 58 67
Advanced Control: Cross-Axis Feedforward

- Reduce position error on an axis due to acceleration of another axis

Reduce cross-axis position error during acceleration

Position Error in Z-Axis Resulting from 1 mm Step in Y-Axis

Without cross-axis feedforward

With cross-axis feedforward

15x reduction in peak error
# Fieldbus and Networking

Aerotech controllers support a multitude of industry-standard communication protocols to facilitate easy component networking, device connectivity and superior motion system performance.

## Networking Type

<table>
<thead>
<tr>
<th>Networking Type</th>
<th>Plant</th>
<th>Fieldbus</th>
<th>Motion</th>
<th>Drive I/O</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3200</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Ensemble</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Soloist</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

## Summary

- Aerotech controllers connect seamlessly to your existing corporate network or PC via these standard protocols.
- Aerotech controllers support a variety of fieldbus communication protocols to fit your application.

Aerotech controllers use state-of-the-art communication standards for motion network communication to ensure a robust, high-performance system.

Aerotech drives include a standard complement of on-board analog and digital I/O, with an option for an expanded I/O board.

*Coming Soon

---

Fieldbus I/O with Hilscher NetX technology

Corporate networking protocols allow remote control and monitoring of your motion system.

Fieldbus communication protocols provide extensive options for communicating with PLCs and other components in your system. Aerotech’s motion networking architectures are truly plug-and-play, making setup quick and easy.
Hexapod Control

- 4U high, rack-mount, six-axis controller for brush, brushless, and stepper motors
- Ideal for controlling six-axis robotic systems like hexapods
- Real-time A3200 distributed control architecture allows synchronized motion on up to 32 axes
- FireWire® or ASCII command interface via TCP/IP
- Optional integrated encoder multipliers for high-resolution positioning and reduced integration complexity
- Optional six-axis jog pendant
- Program in native RS-274 G-code, AeroBasic command set, C, C++/CLI, .NET, MATLAB®, LabVIEW®, or IEC61131-3 (LD, FBD, ST) for the ultimate in programming flexibility

Aerotech’s HEX RC is a high-performance, 6-axis motion controller ideal for controlling robotic systems like hexapods. The HEX RC is 4U high, rack-mountable, and compatible with the Automation 3200 (A3200) motion platform. A high-performance processor provides the intense computing power needed to run up to 32 axes, perform complex, synchronized motion trajectories, manipulate I/O, and collect data at high speeds.
The Ensemble QL/QLe™ panel-mount nanopositioning piezo drive family is designed for seamless use with the Ensemble family of drives and controllers. The QL/QLe connects to any Ensemble controller network enabling coordinated motion between piezo stages and servo axes at much higher rates than other controller or drive products. This power, versatility, and affordability make the Ensemble QL/QLe drives ideal for applications ranging from the most demanding fundamental scientific research to advanced OEM machine systems.

The Ensemble QDe™ is a high-performance desktop nanopositioning piezo drive designed for seamless use with the Ensemble family of drives and controllers. The QDe connects to any Ensemble controller network enabling coordinated motion between piezo stages and servo axes at much higher rates than other controller or drive products. This power and versatility make the Ensemble QDe ideal for single or multi-axis applications ranging from fundamental scientific research to advanced OEM machine systems.

The Ensemble QLAB™ is a high-performance nanopositioning piezo stage controller for 1 to 4 axes of motion. The flexible controller platform allows user-configurable open-loop and closed-loop operation on a per axis basis. Simple software commands allow the user to switch between open-loop and closed-loop if an axis is configured for closed-loop mode.
Controller Comparison Chart

Unsure about which controller is right for your application? Consult the chart to see which controller fits your needs.

<table>
<thead>
<tr>
<th>Basic Functions</th>
<th>A3200</th>
<th>Ensemble</th>
<th>Soloist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-Axis</td>
<td>Up to 32 axes coordinated</td>
<td>Up to 10 axes coordinated</td>
<td>Single axis</td>
</tr>
<tr>
<td>Architecture</td>
<td>PC-based software controller</td>
<td>Stand-alone</td>
<td>Stand-alone</td>
</tr>
<tr>
<td>Number of Tasks</td>
<td>32</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>CNC Functionality/RS-274</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Coordinated Motion</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Point-to-Point Motion</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Cutter Compensation</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multi-Block Look-Ahead</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acceleration Limiting/Look-Ahead</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gantry Mode</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Velocity Blending</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Electronic Gearing</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Electronic Cam Profiling</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Arbitrary Path Generation</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Jog and Offset, Jog and Return</td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>Velocity Profiling</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Retrace (Block by Block)</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axis Calibration</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3D Error Mapping</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Sinusoidal Commutation</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Analog Power Control</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Servo, Stepper or DC Motor Controller</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Expanded IO Available</td>
<td>✓</td>
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<tr>
<td>Encoder Tuning</td>
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<td>✓</td>
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<tr>
<td>Dual Loop Control</td>
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<tr>
<td>PLC (IEC 61131-3)</td>
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<tr>
<td>Advanced Functions</td>
<td>A3200</td>
<td>Ensemble</td>
<td>Soloist</td>
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<tr>
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<td>-------</td>
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<tr>
<td><strong>IDE</strong></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td><strong>.NET, AeroBasic™</strong></td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Fast Position Capture</td>
<td>✓</td>
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<td>High-Speed Registration</td>
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<td>On the Fly End-Point Modification</td>
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<td>Orthogonality Correction</td>
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<tr>
<td>Parts Rotation</td>
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<tr>
<td>Intra-Block Retrace</td>
<td>✓</td>
<td></td>
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<tr>
<td>Iterative Learning Control</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td><strong>PSO</strong></td>
<td>✓</td>
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<tr>
<td>Harmonic Cancellation</td>
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<td>Direction Gain Scheduling</td>
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<td>Inertial Damping</td>
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<td><strong>Friction Compensation</strong></td>
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<td>Linear Drive Amplifiers</td>
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<td>Machine Retrofit Hardware Available</td>
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<td>Galvo Integration</td>
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<td>Seven Segment Acceleration Profile</td>
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<tr>
<td>Slice Move</td>
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<tr>
<td>Corner Rounding</td>
<td>✓</td>
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<tr>
<td>Coordinate Transformations</td>
<td>✓</td>
<td></td>
<td>With Plug-In</td>
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<tr>
<td><strong>Kinematics</strong></td>
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<td></td>
<td>With Plug-In</td>
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<tr>
<td>Loop Transmission</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Advanced Diagnostics and Tuning</td>
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<tr>
<td>Auto Focus</td>
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<td><strong>MATLAB®</strong></td>
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<td>Force Control</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Soft Landing</td>
<td>✓</td>
<td>✓</td>
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<td>Piezo Nanopositioners</td>
<td>✓</td>
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<tr>
<td>HexGen Hexapod</td>
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<tr>
<td>RCP-DELTA Delta Robot</td>
<td>✓</td>
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</tr>
</tbody>
</table>

**Use the Best Controller for Your Application**
Aerotech Electrical Value

- Wired and tested consoles
- Wired panels and 19-inch racks
- Integrated subsystem with PC, controls, drives, cables, power supply or transformer, line filtering, PLC motion, I/O and customer I/O
- CE/UL standards
- Comply with NFPA79 wiring standard

Nsys Complete Consoles

Complete consoles are available that integrate all of the electronics for your system, including the controller, drives and/or drive racks, I/O and monitor.
<table>
<thead>
<tr>
<th>Safety Level</th>
<th>Fault Detection</th>
<th>Loss of Safety Function Probability</th>
<th>Single Fault Covered</th>
<th>Double Fault Covered</th>
<th>Input ESTOP Signal</th>
<th>Supply Power to Drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category B</td>
<td>None</td>
<td>Very High</td>
<td>No</td>
<td>No</td>
<td>No specific design</td>
<td>No specific design</td>
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<tr>
<td>Category 1</td>
<td>None</td>
<td>Very High</td>
<td>No</td>
<td>No</td>
<td>Simple mushroom switch</td>
<td>One relay</td>
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<tr>
<td>Category 2</td>
<td>Low</td>
<td>High</td>
<td>No</td>
<td>No</td>
<td>Simple mushroom switch</td>
<td>One positive guided relay with auxiliary contact for checking</td>
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<tr>
<td>Category 3</td>
<td>Medium</td>
<td>Medium</td>
<td>Yes</td>
<td>No</td>
<td>Dual circuit mushroom with fault detection</td>
<td>Two positive guided relays with cross checking</td>
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<tr>
<td>Category 4</td>
<td>High</td>
<td>Low</td>
<td>Yes</td>
<td>Yes</td>
<td>Dual circuit mushroom with independent fault detection</td>
<td>Two positive guided relays with cross checking</td>
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</table>
## Hardware Options

### A2200 Drives

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<thead>
<tr>
<th>Axes</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1 to 8</th>
<th>1 to 8</th>
<th>2 or 4</th>
<th>2 or 4</th>
<th>3</th>
<th>1 to 12</th>
<th>N/A</th>
<th>N/A</th>
<th>N/A</th>
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<tbody>
<tr>
<td>Output Type</td>
<td>PWM</td>
<td>PWM</td>
<td>PWM</td>
<td>Linear</td>
<td>Linear</td>
<td>PWM and Linear</td>
<td>PWM and Linear</td>
<td>Three-Phase ±10 V</td>
<td>Clock and Direction</td>
<td>Clock and Direction</td>
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<tr>
<td>Standard I/O</td>
<td>1-AI</td>
<td>6-DI/4-DO</td>
<td>6-DI/4-DO</td>
<td>6-DI/4-DO</td>
<td>6-DI/4-DO</td>
<td>Multiple Configurations Available</td>
<td>1-AI per axis</td>
<td>11-DI/8-DO</td>
<td>4-AI/2-AO</td>
<td>16 Assignable I/O</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>Optional I/O</td>
<td>1-AI</td>
<td>1-AI/1-AO</td>
<td>1-AI/1-AO</td>
<td>1-AI/1-AO</td>
<td>1-AI/1-AO</td>
<td>Multiple Configurations Available</td>
<td>Via Optional Ethernet Port</td>
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<td>N/A</td>
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<tr>
<td>I/O Spec</td>
<td>12-bit differential AI</td>
<td>16-bit differential AI</td>
<td>16-bit differential AI</td>
<td>16-bit differential AI</td>
<td>16-bit differential AI</td>
<td>Npaq or HEX RC: Four 16-bit differential AI</td>
<td>Same as ML or MP per axis</td>
<td>EPaq or EPaq MR: Same as ML or MP per axis</td>
<td>Ensemble QLAB: 4 AI, 4 AO</td>
<td>Ensemble QDe: 1 16-bit, 1 18-bit</td>
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<td>N/A</td>
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<tr>
<td>Incremental Encoder</td>
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<tr>
<td>Absolute Encoder</td>
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<tr>
<td>Resolver/Inductosyn</td>
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<td>Capacitive Probes</td>
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<td>Laser Interferometers</td>
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</tr>
</tbody>
</table>

All units capable of sinusoidal commutation, dual-loop control and drive brushless, brush, or stepper motor.
The BA series amplifiers are Aerotech’s stand-alone PWM drive for three-phase AC brushless and single-phase DC brush motors.

BL series amplifiers are highly reliable linear brushless servo amplifiers.

**BA PWM Amplifiers**
- Wide output power range from 10 A peak to 100 A peak at 320 VDC
- No transformer required; direct connection to AC line
- Capable of running brushless or single-phase DC brush motors
- Velocity, torque and dual-phase mode input command
- Accepts both encoder or tachometer feedback for velocity control
- Can be externally commutated
- UL, CE and CSA approval

**BL Linear Amplifier**
- Non-switching, high-performance linear operation for ultra-smooth control of brushless motors
- Totally modular design accepts 110 VAC or 220 VAC input power
- Ideal for air-bearing systems and noise-sensitive applications
Aerotech Servomotors

- Ironless/cogless design for superior motion
- Iron-core motors for high force output
- Frameless torque motors for custom machines
- Ultra-precision positioning
- Low heat generation
- Vacuum compatible options
- NEMA 17, 23, 34, 42 and IEC 142

Rotary Motors

### Torque

**Type:** Brushless
- Continuous Torque: 0.16 - 31.6 N·m
- Peak Torque: 0.48 - 94.9 N·m
- Rated Speed: 2400 - 4000 rpm

**Type:** Brushless, Slotless
- Continuous Torque: 0.33 - 2.86 N·m
- Peak Torque: 1.31 - 11.43 N·m
- Rated Speed: 2000 - 4000 rpm

**Type:** DC Brush
- Continuous Torque: 0.25 - 1.48 N·m
- Peak Torque: 1.84 - 7.1 N·m
- Rated Speed: 3000 - 6000 rpm

**Type:** Stepper
- Continuous Torque: 0.3 - 7.4 N·m
- Peak Torque: —
- Rated Speed: —

Full line of DC brush, brushless, servo and stepper motors to fit almost any situation.

Brushless motors feature neodymium iron boron magnets for maximum torque and acceleration in a small package.
**Frameless Rotary Motors**

Aerotech’s proprietary coil winding technology produces the highest force to volume ratios available. Direct drive, noncontacting forcer coil eliminates backlash, windup and wear for a maintenance-free system. Five frameless designs for easy integration into OEM machines. Slotless stator and high-pole-count rotor provide zero cogging for exceptional velocity control.

**Torque**

<table>
<thead>
<tr>
<th>Type</th>
<th>Continuous Torque</th>
<th>Peak Torque</th>
<th>Rated Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frameless</td>
<td>0.20 - 29.09 N·m</td>
<td>0.82 - 116.37 N·m</td>
<td>200 - 8000 rpm</td>
</tr>
</tbody>
</table>

**Force**

<table>
<thead>
<tr>
<th>Type</th>
<th>Continuous Force</th>
<th>Peak Force</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat</td>
<td>19 - 697 N</td>
<td>75 - 1507 N</td>
</tr>
<tr>
<td>U Channel</td>
<td>18.3 - 1063 N</td>
<td>125 - 4252 N</td>
</tr>
</tbody>
</table>

**Brushless Linear Servomotors — Flat and U-Channel**

Advanced magnetic field synthesis and analysis yields highest motor output power per unit volume.

Advanced linear servomotors are ideal for:

- Robotics
- Packaging
- Actuators
- Tables/Stages
- Assembly
- Fiber Optics/Photonics
- Alignment and Positioning
- Machine Tools
- Semiconductor Equipment
- Electronic Manufacturing
Custom Motors
We customize for you

- Change Thermistor
- Cable Exit on Side
- Change Port Interface
- Change Coil Winding
- Longer or Shorter Track
- Add Hole for Sensor
- Longer Stack
- Smaller OD
- Different Winding
- Higher Strength Magnet
- Larger ID

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- Change Coil Winding Length
- Longer or Shorter Track
- New Mounting Interface
- New Winding
- Different Flange
- Change Shaft
- Shorter Housing
- Higher Load Bearings
- Different Encoder
Available Accessories:

Maple Operator Interface  Power Supplies  Line Filters
Joystick                  Cables              Panel PC
Handwheel/Pendant         Automation Server    
Transformers              MXH Multiplier Boxes
We customize for you...

Hardware • Software • Firmware • Packaging • Motors • HMI • Electronics • I/O

**Custom Automation**
- Coordinate motion, PLC, robotics, vision, and communications with one automation control
- Galvo control
- Piezo control
- Integration with process control
- HMI integration

**Custom Software**
- Custom operator interfaces
- Custom applications
- Custom software libraries
- Program in nearly any language

**Custom Motor Design**
- Custom motors optimized for your specific application at a minimal price
- Customized motor mechanical characteristics including torque/force, length, width, height
- Customized motor electrical characteristics including bus voltage, resistance, inductance, pole pitch, and current
- Custom motors for low-volume projects
- Completely new motor design

**Custom Drives**
- Plug-in architecture speeds development of custom algorithms. For example, 2D bar code, interfaces to non-standard sensors, and signal outputs synchronized to servo sample time
- Packaging can be customized for specific form factor and space constraints
- Custom algorithms can be developed at the firmware layer

**Custom Control Algorithms**
- Create algorithms at the application, motion engine, firmware, or hardware layer
- Flexible control architecture
- Custom kinematics

**Connectivity**
- Ethernet
- Fieldbus
- Wireless
- USB

**Vision Integration**
- Interface with standard cameras and machine vision systems
- Registration marks or fiducials can be located and used as a home or reference position
- Vision can be coordinated with servo motion for vision guided robotics

**Customization Features**
- Vision can be integrated with standard cameras and machine vision systems
- Registration marks or fiducials can be located and used as a home or reference position
- Vision can be coordinated with servo motion for vision-guided robotics
We implement with you...
Tuning • Parameters • Optimize Performance • HMI • Write Software

We will work with you onsite or at our facility to meet your machine specifications.

Aerotech personnel will:
- Perform parameter setup and system tuning
- Setup of the Advanced Controls Toolbox to achieve the highest performance possible
- Write motion programs in AeroBasic
- Write software (.NET, C) by applying our libraries

Benefits include:
- Maximize machine performance
- Minimize machine development time
- Minimize cost
- Write/configure HMIs
- Integration with process controller

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Markets and Industries

Aerotech controls and components have become the preferred solution for a variety of applications in a host of industries around the world.

- Laser Processing
- Semiconductor Processing
- Military and Aerospace
- Electronics Manufacturing
- Medical Device Manufacturing
- Test and Inspection
- Machine Tools
- Automotive
- Packaging
- University
- Industrial R&D
- Photovoltaic Manufacturing
Aerotech Customer Applications

A3200
• Stencil Cutting
• Wire Bonding
• Die Bonding
• Optics Polishing
• Stent Manufacturing
• e-Beam Welding
• EDM
• Drilling and Milling
• Grinding and Polishing
• Waterjet Cutting
• Fuel Injector Drilling
• Fuel Cell Manufacturing
• Crystallography
• Target Tracking
• Beam Steering
• Pipe Thread Measurement

A3200 or Ensemble
• Dispensing (Printed Electronics, Material Dispensing)
• PCB Assembly (Pick and Place of SMT, Through-Hole)
• VIA Drilling
• Wafer Scribing and Singulation (Dicing)
• Die Bonding
• Resistor Trimming
• AOI/X-Ray Inspection
• Chip Testing
• Chip Packaging
• Crystallography
• Flat Panel
• Semiconductor Testing
• Semiconductor Manufacturing
• Photovoltaic Cell Manufacturing
• DNA Analysis
• Image Duplication
• Holographic Writing
• Sensor Testing
• Sensor Manufacturing

Ensemble
• Packaging Machines (Multi-Axis Applications)
• Web Applications
• Printing Applications
• Rollover Unit Testing
• IMU Testing
• ECM
• Marking
• Vertical Form, Fill, and Seal

Soloist
• EDM & ECM
• Packaging Machines (Case Erectors, Labeling Machines, Augers)
• Printing
• Gyro Testing
• Accelerometer Testing
• Optical Polishing (Spindle Axis)
• Beam Steering
Stent and Medical Device Manufacturing

Aerotech’s experience in market-specific solutions provides an edge in processes involving photonics, semiconductor processing, medical device manufacturing and laser processing. With a number of specially developed motion platforms for these industries, Aerotech provides a one-stop-shop for your motion requirements.

Controllers to Use:
• A3200

Solar Panel Scribing

Extensive application experience and a broad array of motion products make Aerotech the perfect partner for your photovoltaic (solar cell) manufacturing or testing platform. Our worldwide operation has engineered and manufactured a multitude of motion platforms for solar cell manufacturing and inspection. These platforms range from small format systems for R&D to full-size production panel processing systems.

Controllers to Use:
• A3200
• Ensemble

Aerotech’s highly successful Vasculathe® and LaserTurn® platforms deliver maximum productivity in a compact, easy to maintain package with the lowest cost of ownership in the industry. With the A3200’s PSO functionality, the throughput possible with the LaserTurn® and Vasculathe® series is unmatched.
Packaging

Line following applications including:
• Labeling, cut-to-length, fly cutting, lane diversion, rotary knife and many others.

Basic features for line following:
• Auxiliary encoder input for measuring line speed
• High-speed registration for measuring line position
• The relationship between line speed/position can be an arbitrary function or simply 1-to-1

Controllers to Use:
• Soloist
• Ensemble
• A3200

High Accuracy, Multi-Axis Inspection Systems

The A3200 controller is uniquely suited to complex inspection applications like turbine blade inspection that requires 5 axes or more of coordinated motion integrated with a sensor or camera.

Controllers to Use:
• A3200 with linear drives
Optical Mounts and Gimbals

- Directing optics, lasers or antennas
- LOS target tracking
- Precision pointing

Controllers to Use:
- A3200
- Ensemble

Fuel Cell Manufacturing Operations

- Laser machining the membranes (also referred to as MEAs)
- Welding the plates/membranes together
- Stacking the membranes into a cell
- Inspection of the MEAs, plates and cells

Controllers to Use:
- A3200
Controls Timeline

With 40 years in the business of designing and building motion systems, Aerotech has the experience and knowledge to understand the challenges and solutions of industrial and laboratory processes.
Aerotech has manufactured advanced motion controllers since 1970. From the industry workhorse PCI cards to state-of-the-art software-based control coupled with intelligent networked drives, the science of motion control has been our business for decades.
Worldwide Training and Support

Aerotech offers comprehensive worldwide training and customer service at customer facilities or at one of our Aerotech training centers.

Training Program:
- Standard and customized courses
- Hands-on training with Aerotech controllers
- Interactive training with experienced instructors
- Comfortable, spacious facilities
- Online training modules
- Online FAQs
- At customer site or at Aerotech

Installation and Startup (Commissioning)

Aerotech offers startup and commissioning services to minimize startup times, reduce costs and accelerate time-to-production. By combining our product knowledge with your process and application expertise, new systems and applications can be completed faster and at a reduced overall cost.

Engineering Support

Aerotech provides complete engineering support for our products, including onsite support and maintenance, and remote support via phone, fax, website and/or WebEx® software. As a manufacturer staffed by engineers, we understand the unacceptability of downtime.

Join.Me.

Aerotech can remotely support your startup, commissioning and debugging of systems over the internet.
Aerotech is an ISO 9001 Registered Company

Since 1995, Aerotech’s quality system has been certified to the ISO 9001 standard. The ISO 9001 standard encompasses the Aerotech organization through manufacturing.

As part of our commitment to the ISO standard, we formally survey our customers on a monthly basis which provides valuable feedback to continually improve our products and processes.
Aerotech at a Glance

High-Volume Manufacturing

Over 100,000 axes installed worldwide

Worldwide Service and Support

Worldwide startup service and on-site training

Fully equipped on-site training facilities

Technically Superior Components

Highest performance brushless linear and rotary motors

ADRT rotary stages

ALS1000 linear motor stage

A3200 Soloist Ensemble

Award-winning Automation 3200
1-32 axis motion, vision, PLC, robotics and I/O platform
High Performance Sub-Assemblies

- XYAB subsystem for high dynamic accuracy positioning in laser drilling and micromachining applications
- HexGen high-load, ultra-precision hexapod provides unmatched performance
- Highest throughput linear motor Cartesian gantry systems

Best-in-Class Subsystems

- Highly integrated motion subsystems with machine frame, display and packaged electronics
- Custom-engineered, vacuum and cleanroom compatible systems
- RCP-Delta robot capable of 15g’s of acceleration and up to 200 pick and place operations per minute

Comprehensive Technical Support Services

- Custom software application support
- 3D models to facilitate faster and more accurate system layout
- Advanced analytical techniques for optimization of system geometry
Aerotech Worldwide

- Aerotech Headquarters
- Direct Field Sales Office
- Aerotech Subsidiary
- Representative

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