

# Integrated Automation Solutions



# Contents

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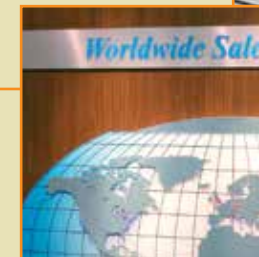
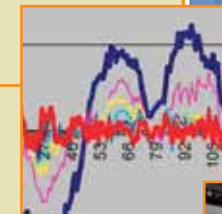
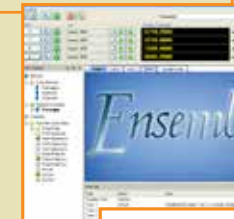
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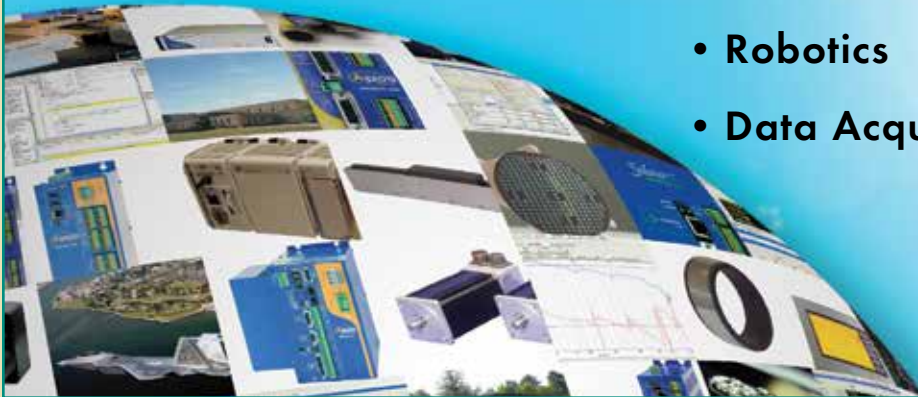
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# Aerotech's

## Advanced Automation Technologies: 40 years in the making... and going strong...

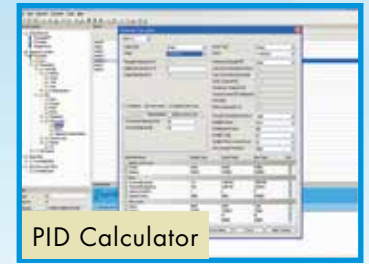
- Controls
- Software
- Amplifiers
- Motors
- PLC
- Fieldbus
- I/O
- Vision
- Peripherals
- Robotics
- Data Acquisition



# 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



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

## Award-Winning Controllers



### Automation 3200

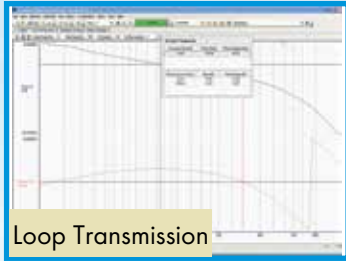
- PC-based
- 1 to 32 axes of coordinated motion
- Up to 32 tasks
- RS-274 (G-code)
- Advanced features for demanding applications
- PWM or linear drives (up to 150 A)
- Scanner control for marking
- Tightly integrated laser functionality
- Retro-fit package for old controls
- Integrated PLC and Motion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

### Ensemble™

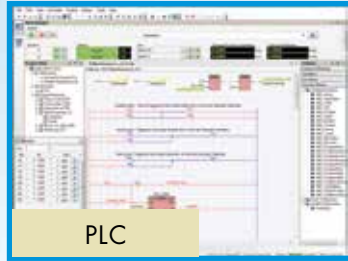
- Stand-alone
- 1 to 10 axis controller
- Up to 4 tasks
- Versatile, cost-effective, coordinated motion
- PWM or linear drives (10-150 A peak)
- Drives brushless, linear, rotary, DC brush or stepper motors
- Desktop, rack mount or panel mount

# Configure Your Automation Solution with Aerotech

## Environment, Calculators, Diagnostics



Loop Transmission



PLC

## Linear and Rotary Servomotors/Accessories



## LabVIEW®, Tango, AeroBasic™ or PLC languages



### 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

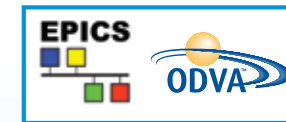


### Piezo Controls

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

## Fieldbus and Network Connectivity

- EtherNet/IP™
- PROFINET
- Modbus®/TCP
- RS-232
- EtherCAT™
- Ethernet TCP/IP
- USB
- GPIB



## Custom Controls, Drives and Motors



# 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

The screenshot shows the Ensemble AEROTECH software interface. On the left is a Network Explorer tree view. The main window displays a 'CfmMotType Parameter' configuration page with a table of motor settings and a help browser. Callout boxes point to various features:

- 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

Axis	X	Y	Z	U
CfgMotType	4	4	4	4
CfgMotCyclesPer	4000	4000	4000	1000
CfgMotDir	1	1	1	1
CfgMotSoftStart	1000	10	10	10
CfgMotStepPulse	4000	4000	4000	4000
CfgMotStepperHighCur	2	2	2	2
CfgMotStepperLowCur	1	1	1	1
CfgMotStepperOSan	0	0	0	0
CfgMotStepperVref	0	0	0	0

Mode	Motor Type
0	AC brushless with Hall effect switches
1	AC brushless without Hall effect switches <sup>(1)</sup>
2	DC brush

# Calculators for Quick and Easy Setup

The image shows a screenshot of the 'Parameter Calculator' software interface. The interface is divided into several sections: a left-hand tree view, a central configuration area, and a bottom parameter table. Callouts with orange boxes and lines point to various features:

- Current loop calculator**: Points to the 'Digital Current Loop' tab.
- PID gain calculator**: Points to the 'Feedback' tab.
- Configure feedback for user units**: Points to the 'Units' dropdown menu.
- Easily switch axis to be configured**: Points to the 'Axis' dropdown menu.
- Select your motor or add a custom motor**: Points to the 'Motor' dropdown menu.
- System knows all parameters of Aerotech components**: Points to the 'Motor Type' dropdown menu.
- Select amplifier type**: Points to the 'Amplifier Type' dropdown menu.
- Directly enter any parameter values here**: Points to the 'New Value' column in the parameter table.
- Summary of default, current and new values for all parameters**: Points to the entire parameter table.

The parameter table at the bottom contains the following data:

Parameter Name	Old Value	Current Value	New Value	Set?
Digital Current Loop				
IGainI	8600	8600	27000	☐
IGainP	61000	61000	7000	☐
Motor				
ThresholdVgAmp	2.6	2.6	2.367143	☐
ThresholdClampAmp	10.6	10.6	9.367142	☐
Servo Loop				
GainI	6000	600	3000	☐
GainP	44000	67000	140000	☐



# Extensive Diagnostics for all System Signals and Variables Shortens Debug and Startup Time

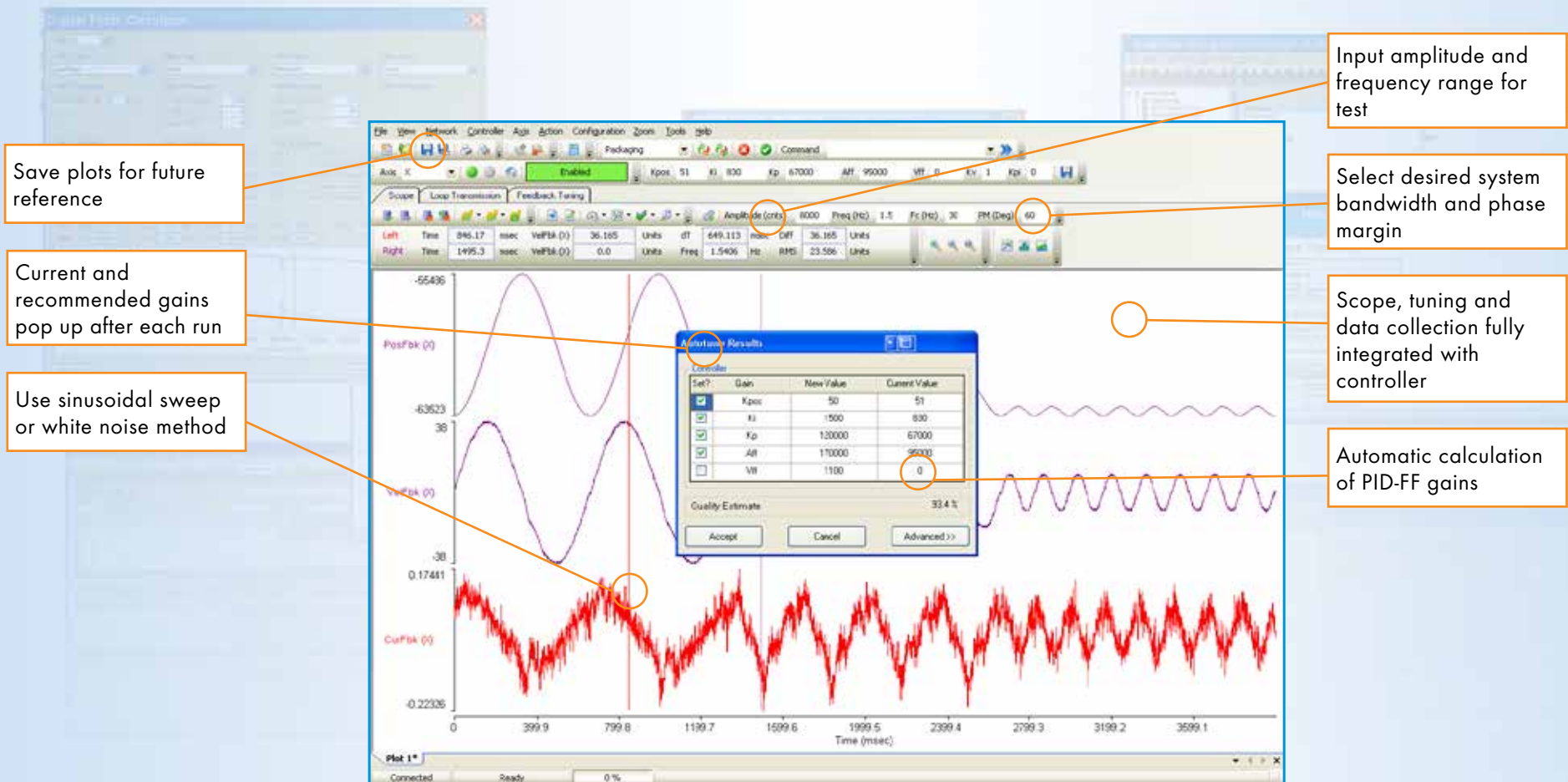
The screenshot shows the Ensemble software interface with several callout boxes pointing to specific features:

- System toolbar for system control**: Located at the top left of the main window.
- Axis toolbar for control of each axis**: Located below the system toolbar, showing controls for X, Y, Z, and U axes.
- Standard toolbar for program control**: Located at the top right of the main window.
- Issue immediate commands without operator interface open**: Points to a 'Command' input field.
- Control all axes at once**: Points to a 'Control' button.
- Multiple tabs for organized programming**: Points to the 'Task List' tabbed interface.
- View task status as needed**: Points to the 'Task List' table.
- Watch any variables as the program runs**: Points to the 'Diagnostic Display' window.
- Pop-up error reporting**: Points to the 'Error' column in the 'Task List' table.
- Compiler output screen**: Points to the 'Compiler Output' window.
- Dockable windows for custom work environment**: Points to the 'Diagnostic Display' window.
- Configurable to see only the information you want**: Points to the 'Property' list in the 'Diagnostic Display' window.
- Real-time readout of system state variables**: Points to the 'Position Command' and 'Position Feedback' fields.
- Real-time access to system signals**: Points to the 'Axis I/O' section in the 'Diagnostic Display' window.
- Real-time reporting of all faults**: Points to the 'Position Error Fault' and 'Over Current Fault' fields.
- Real-time system information**: Points to the 'Axis Status' section in the 'Diagnostic Display' window.

The 'Task List' table shows the following data:

Task	Status	Err.
Auxiliary Task	Inactive	
Task 1	InFault	Axis1NotEnabled, Axis 0 currently disabled
Task 2	Inactive	
Task 3	Inactive	
Task 4	Ready	

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



# Use Encoder Tuning Tool to Increase System Accuracy

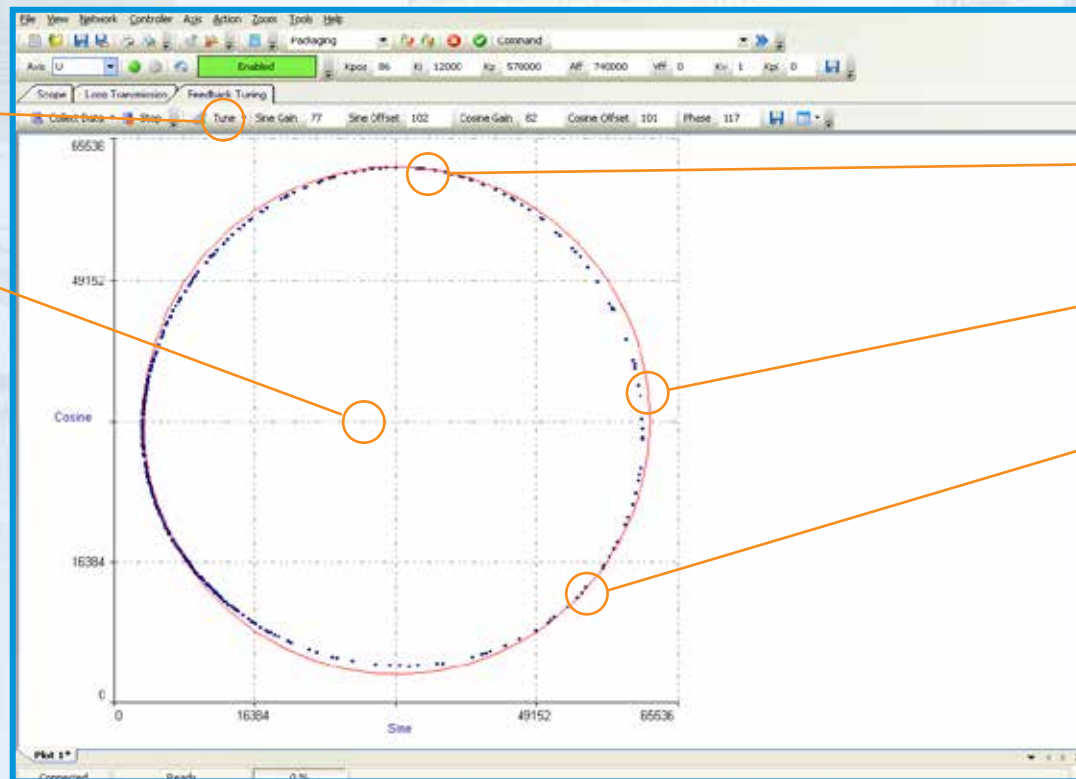
One click tuning

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

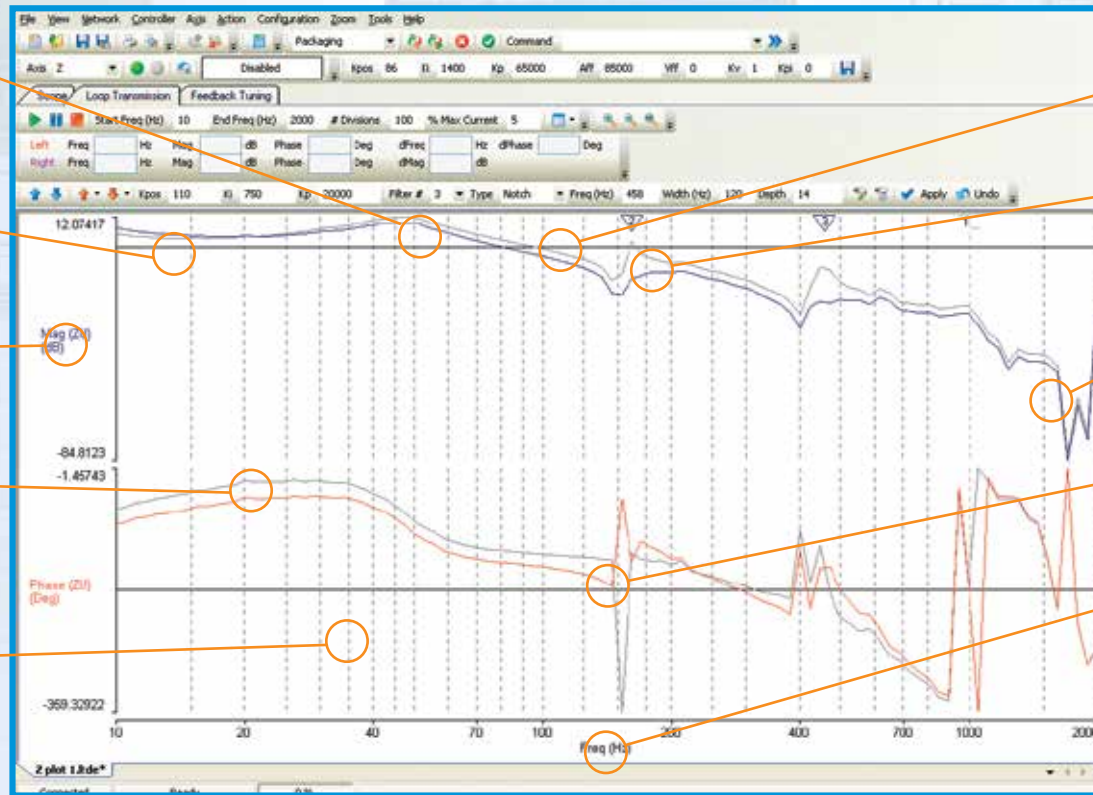
Graphical loop shaping – add filters or change gain by dragging the gain curve, and the filter coefficients and PID gains are calculated automatically

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\*



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

# Fully Integrated Digital Filter Calculator Makes Performance Enhancements Easy

**Axis selection**

Select your filter type: low pass, high pass, notch, resonant, lead/lag

Add up to eight filters per axis

Discrete time gains are automatically calculated and stored in the parameter file

Configure filters for your application by specifying frequency, depth and width

Cursor control to read out gain and phase

Composite frequency response of all filters

Store all parameters in the parameter file

**Digital Filter Calculator**

Axis: X

Filter 1 Type: LowPass  
Filter 2 Type: Notch  
Filter 3 Type: Resonant  
Filter 4 Type: None

Filter 1 Parameters: Cutoff Freq (Hz) 1000  
Filter 2 Parameters: Center Freq (Hz) 1000, Width (Hz) 50, Depth (dB) 40  
Filter 3 Parameters: Center Freq (Hz) 100, Width (Hz) 50, Gain (dB) 20  
Filter 4 Parameters: (None)

Filter	Coef	Value
Filter 1 Coefficients	N0	0.226153999567032
	N1	0.45230698585103
	N2	0.226153999567032
	D1	-0.280945986509323
Filter 2 Coefficients	N0	0.980937453794024
	N1	-2.17769114479404E-16
	N2	0.980552351850469
	D1	-2.17769114479404E-16
Filter 3 Coefficients	N0	1.03435124810707
	N1	-1.96783705291467
	N2	0.958015141202473
	D1	-1.96783705291467
Filter 4 Coefficients	N0	1
	N1	0
	N2	0
	D1	0

Left: Freq 146.17 Hz, Mag 1.41 dB, Phase -40.67 Deg  
Right: Freq 1079.7 Hz, Mag -7.38 dB, Phase -110.93 Deg  
dFreq -933.51 Hz, dPhase -70.26 Deg  
dMag 8.79 dB

Magnitude (dB) vs Frequency (Hz) graph showing a notch at 1000 Hz and a resonance at 100 Hz.

Buttons: Remove, Accept, Cancel, Apply

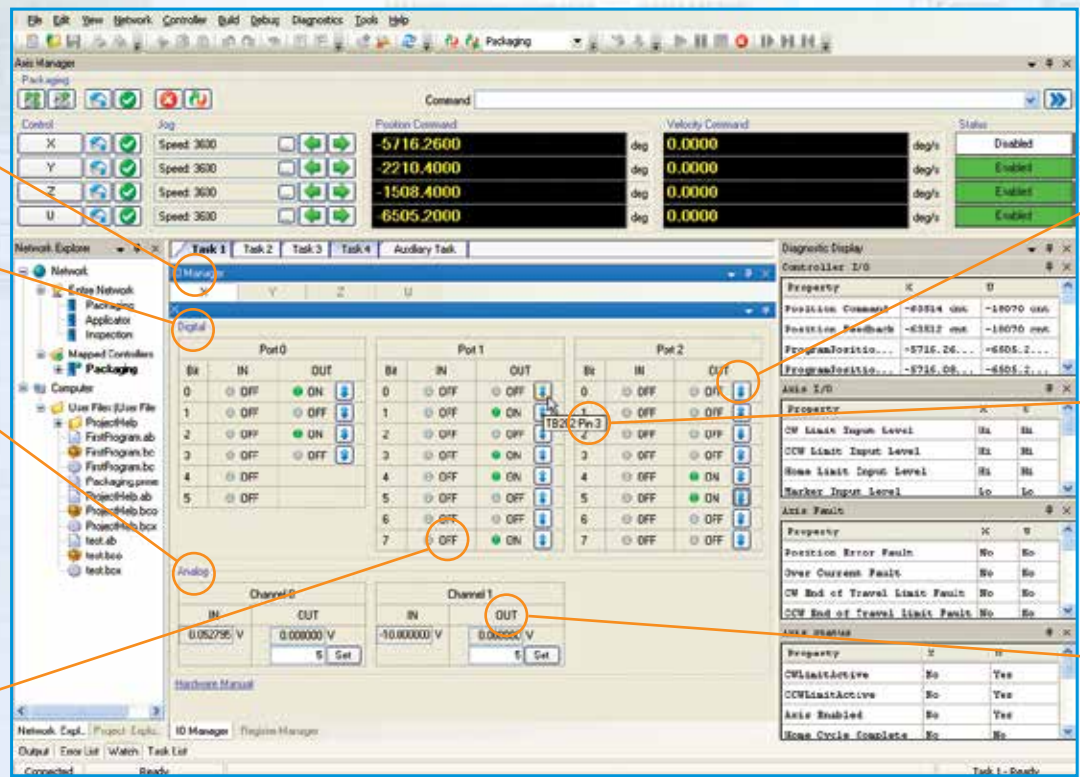
# Integrated I/O Panel for Debug, Commissioning or Operations

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

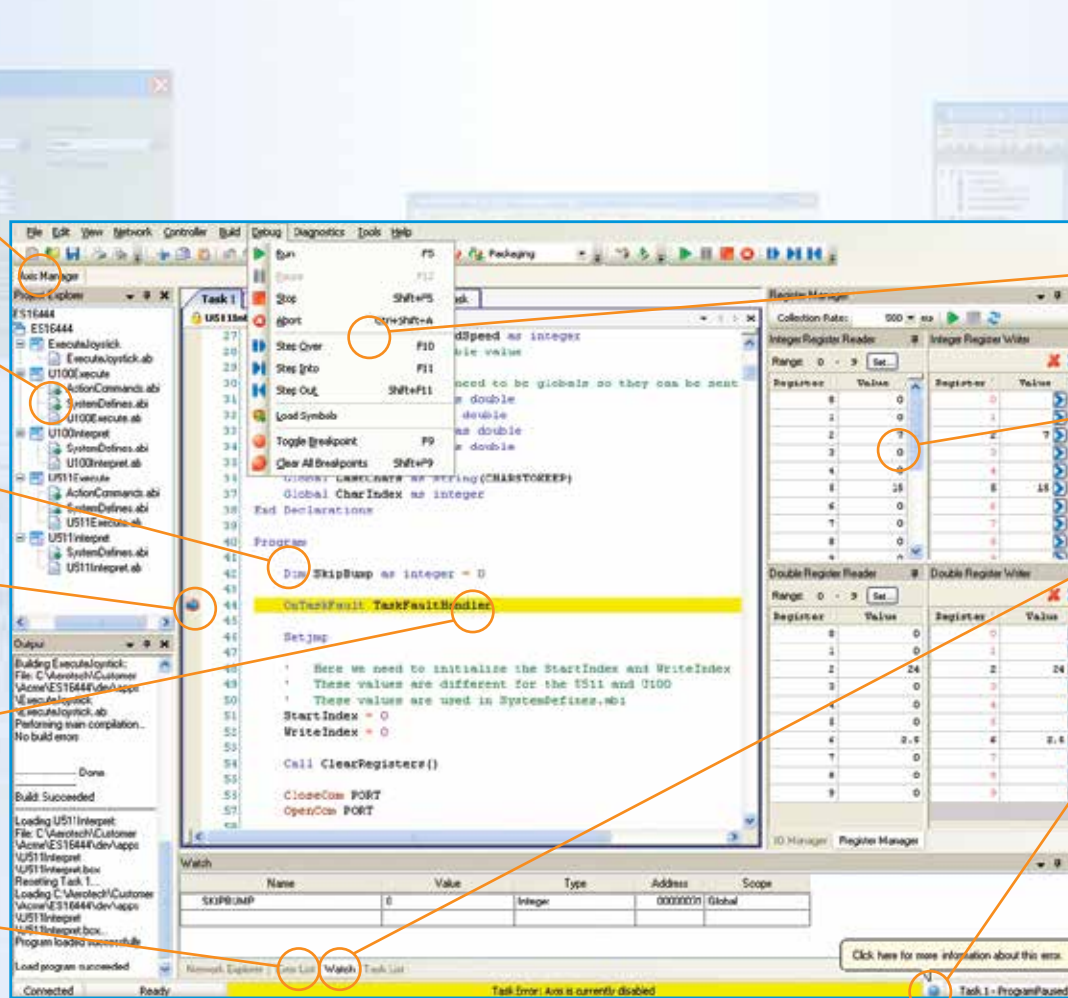
Visual Studio®-like project management for advanced programming

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)

```
1  Header
2
3  #include "DisplayLibrary.aht"
4  #include "PartLibrary.aht"
5
6  #define QUIT_PARTS_PROGRAM -1
7  #define ADD_NEW_PART 0
8  #define MAKE_PART 1
9
10 End Header
11
12 Program
13
14 Dim PartID as Integer
15 Dim PartCount as Integer
16 dim UserAction as Integer
17 Dim PartsMade as Integer
18
19 'If the user selects to quit from the display then negative one is returned.
20 While UserAction <> QUIT_PARTS_PROGRAM
21   UserAction = GetDisplayAction()
22
23   if UserAction = ADD_NEW_PART then
24     'User has selected to enter new part information.
25     Call AddNewDefinedPart()
26
27   elseif UserAction = MAKE_PART then
28
29     'First get the ID of the part they would like to make.
30     PartID = GetPartID()
31     'Get the number of parts they would like to make.
32     PartCount = GetPartCount()
33     'Call the function to actually make the parts
34     PartsMade = MakeParts(PartCount, PartID)
35     'Show the parts count on the display.
36     Call DisplayPartCount (PartsMade)
37
38   ...
39
40 End While
```

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

Use structures to define your own data types

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

```
1 Declarations
2 - Structures to define a rectangular part with round corners
3
4 Type Part
5   ID           as Integer
6   CornerRadius as Double
7   Width        as Double
8   Length       as Double
9   End Type
10 Global PartList(100) as Part
11 End Declarations
12
13 Function CutPart(byref PartToCut as Part)
14   Home X Y
15   If PartToCut.CornerRadius = 0 then
16     Linear X PartToCut.Length F 100
17     Linear Y PartToCut.Width F 100
18     Linear X (-1)*PartToCut.Length F 100
19     Linear Y (-1)*PartToCut.Width F 100
20   else
21     Velocity On
22     Linear X PartToCut.Length F 100
23     CW X PartToCut.CornerRadius Y PartToCut.CornerRadius R PartToCut.CornerRadius
24     Linear Y PartToCut.Width F 100
25     CW X PartToCut.CornerRadius Y (-1)*PartToCut.CornerRadius R PartToCut.CornerRadius
26     Linear X (-1)*PartToCut.Length F 100
27     CW X (-1)*PartToCut.CornerRadius Y (-1)*PartToCut.CornerRadius R PartToCut.CornerRadius
28     Linear Y (-1)*PartToCut.Width F 100
29     Velocity Off
30     CW X (-1)*PartToCut.CornerRadius Y PartToCut.CornerRadius R PartToCut.CornerRadius
31   end if
32 End Function
33
34 Function MakeParts(byval TotalParts as Integer, byval PartID as Integer) as Integer
35   dim PartIndexToMake as Integer = 0
36   dim PartCount as Integer = 0
37
38   while PartID <> PartList(PartIndexToMake)
39     PartToCut = PartList(PartIndexToMake)
40     CutPart PartToCut
41     PartIndexToMake = PartIndexToMake + 1
42   end while
43   PartCount = PartCount + 1
44 end Function
```

Memory management is done by the operating system

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

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

The screenshot displays the MotionPAC software interface. The main window shows a ladder logic program with several motion blocks, including 'Enable Axis', 'Home Axis', 'Run Cycle', and 'ASPC Enable'. The interface includes a 'Project View' on the left, an 'I/O Manager' at the bottom left, and a 'Tag database' on the right. Several callout boxes point to specific features:

- Define hardware**: Points to the hardware configuration section in the top left.
- Create libraries**: Points to the 'Libraries' folder in the Project View.
- Axis manager**: Points to the 'Axis Manager' window at the top.
- Standard LD**: Points to a standard ladder logic rung in the main program.
- Combine LD and FBD in the same program**: Points to a rung that combines standard LD with a motion block.
- Tag database**: Points to the 'Tag database' window on the right.
- Online mode displays all Tag values**: Points to the 'Tag' window at the top right.
- LD, FBD or ST programs**: Points to the main ladder logic editor.
- Completely integrated motion blocks**: Points to a motion block within the ladder logic.

# Integrated Automation: MotionPAC – PLC and Motion



## HMI

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



## MotionPAC

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



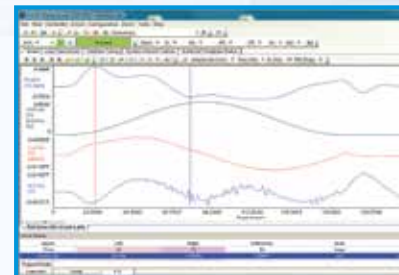
## Central Machine Tag Database

- 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



## Motion Composer

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



## Scope

- Signal capture & analysis
- Autotuning
- Loop transmission
- Encoder tuning
- Advanced controls



## Beckhoff Wago

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

# Use Tags in Operator Interface by Name

The screenshot displays the A3280 CNC Operator Interface. At the top, there are sections for Control (X, Y, Z, U, A), Status (Homed, Disabled), Program Position Feedback, and Velocity Feedback. Below these are sections for Execute Task Command, Run Mode, Retrace Mode, MFO, Configuration (Jog Pad, Velocity, Jog Type), and Select Page (Axis Control). A program editor window is open, showing CNC code with a yellow highlight on line 37: `G90 G1 X10 Y-10 Z-10.0`. The bottom of the interface includes a toolbar with buttons for Open, Close, Edit, Cycle Start, Feedhold, and Abort, along with a status bar showing 'Connected' and 'Task 1 - Program Running'.

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 defined in one place

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 available in all applications: scope, configurator, MotionPAC (PLC) and Motion Composer

From	Signal	I/O	I/O	To	Signal	Type
PLC	eCLR.LDSample1.mfo	←	→	Drive IO	HWIO\NServo\Signal5	WO...
PLC	eCLR.digOut	→	←	Drive IO	HWIO\NServo\Signal3	BOO...

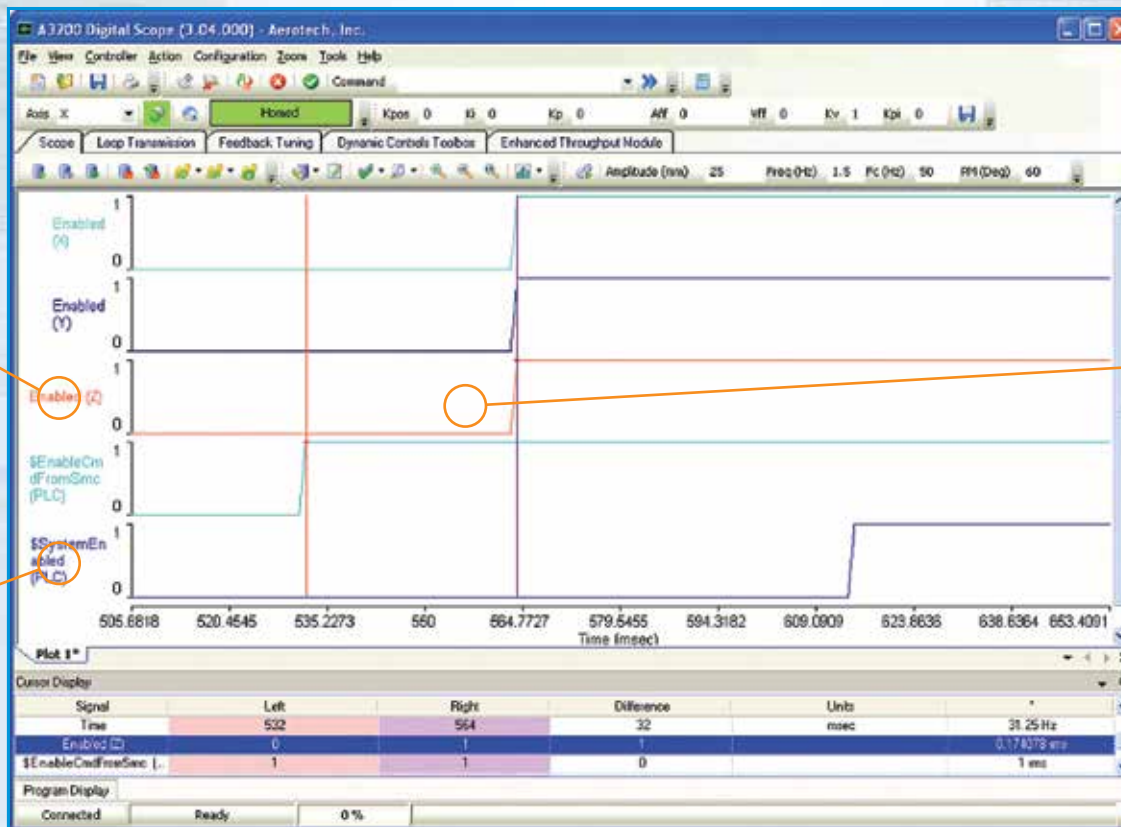
Name	Type	I/O
mfo	WORD	→

I/O	Name	Type
→	Signal3	BOOL
←	Signal4	INT
←	Signal5	WORD

# Use Scope to Plot any Motion, PLC, I/O, Variable or Tag

Motion variables

PLC Tags



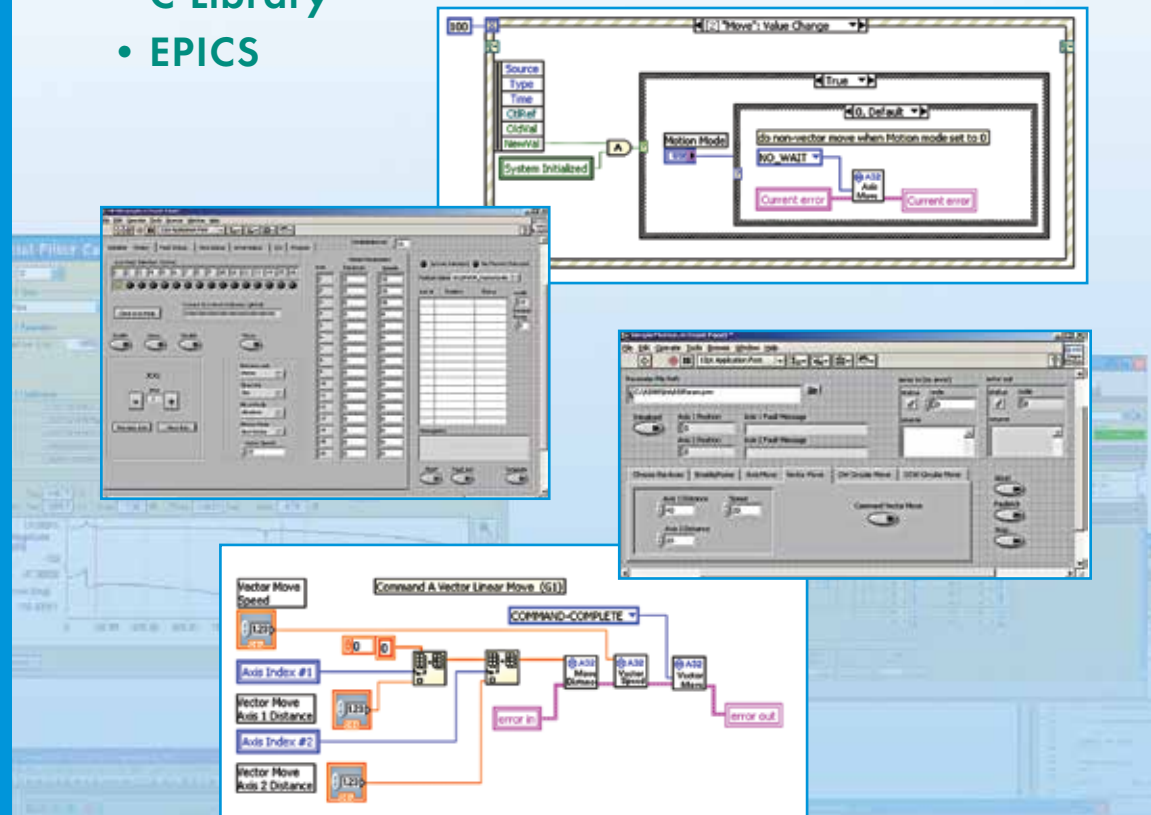
All information in Global Tag database available for real time plotting and analysis with all motion variables

# 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

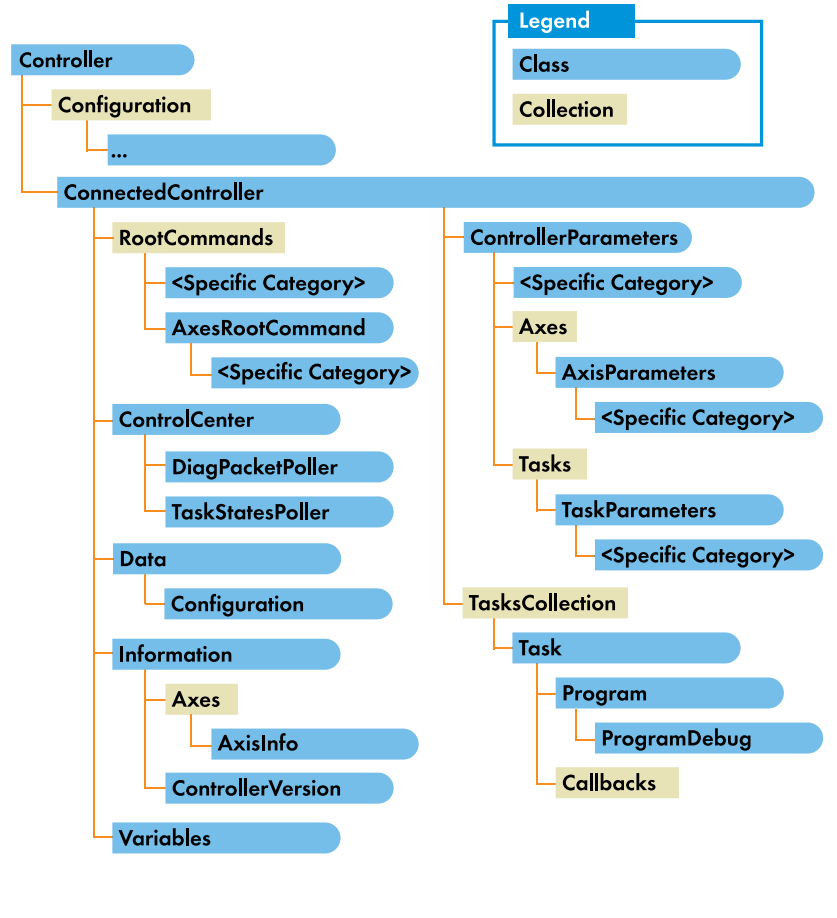
### • Object Model

- 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



# Motion Designer:

## Graphical Trajectory Generation and Data Analysis

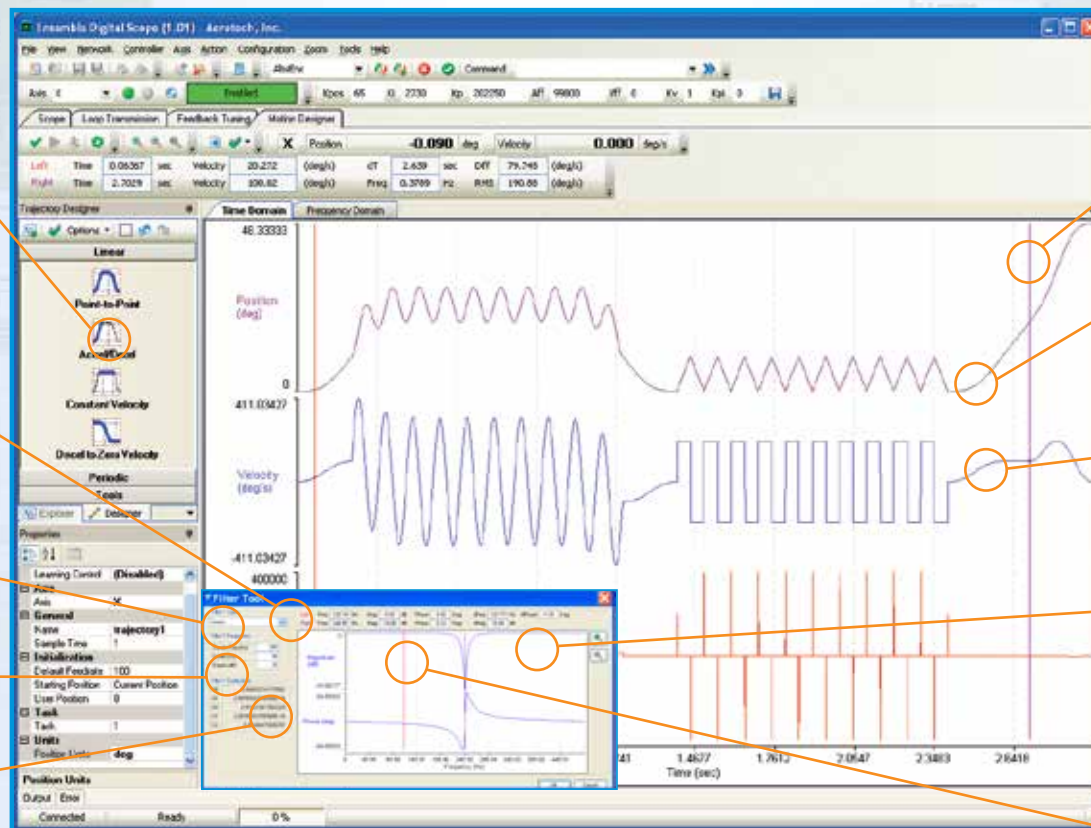
Create and modify multi-axis trajectories using predefined building blocks to provide rapid motion prototyping

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



Cursor control

Apply filters to shape the trajectory frequency content

Import existing position, velocity or acceleration data

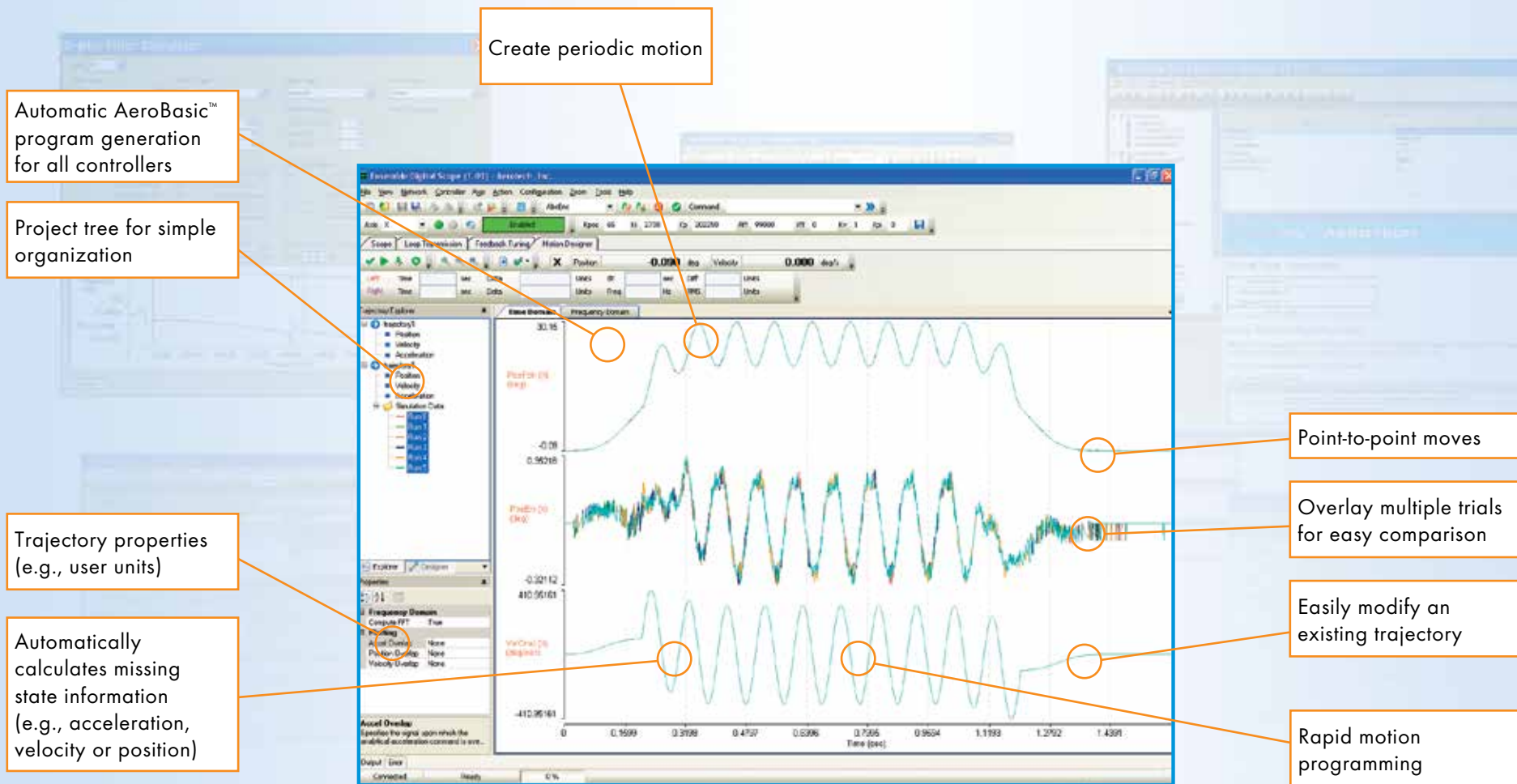
View the composite filter before applying to the trajectory

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



# 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

## Aerotech Motion Simulator – The Integrated, Easy to Use, Graphical Trajectory Generation, Data Analysis and Enhanced Machine Performance Toolkit.

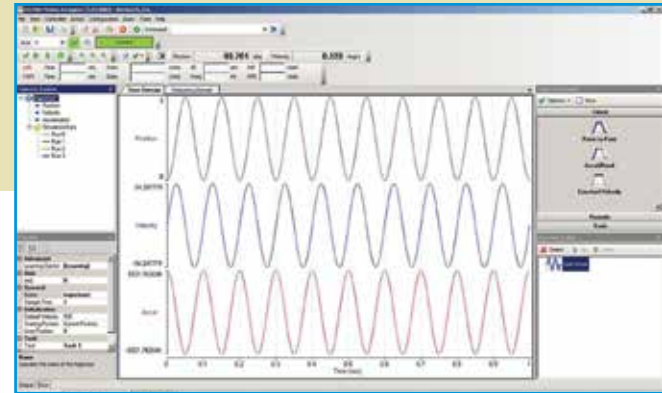
Aerotech's Motion Simulator software is an easy-to-use Windows®-based program for creating simple and advanced motion stimuli for testing and calibrating inertial sensors and systems. The Aerotech Motion Simulator software includes all controls for manually or automatically running 1-3 axis motion simulations. The GUI provides a user interface and programming environment that requires no third-party development software.

### Key Features:

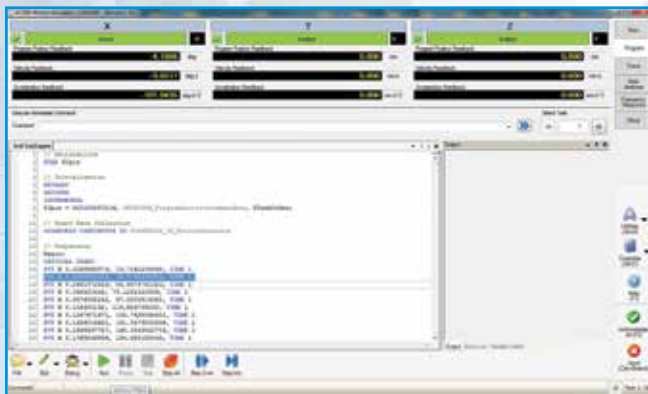
- User-friendly Windows®-based graphical user interface
- Trajectory tracking from Ethernet, analog or Windows® program inputs
- Iterative Learning minimizes position error
- Overlap multiple runs of a trajectory to easily see how program changes modify the motion
- Perform data analysis such as FFT, 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



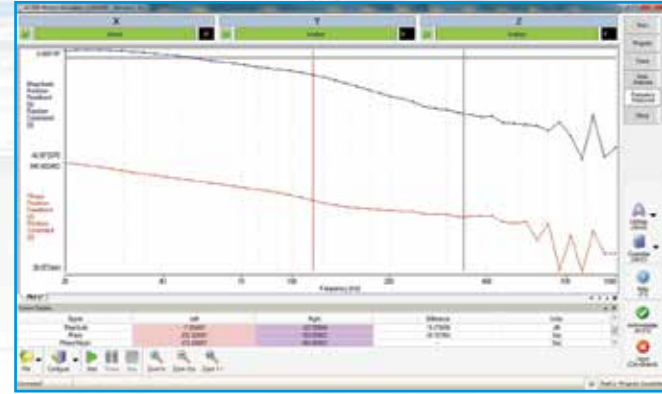
Main Screen



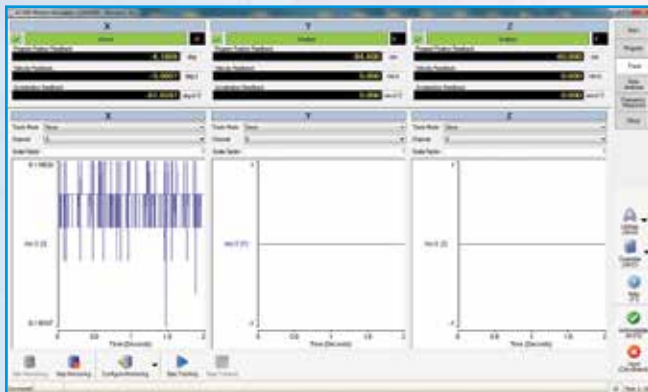
Motion Designer



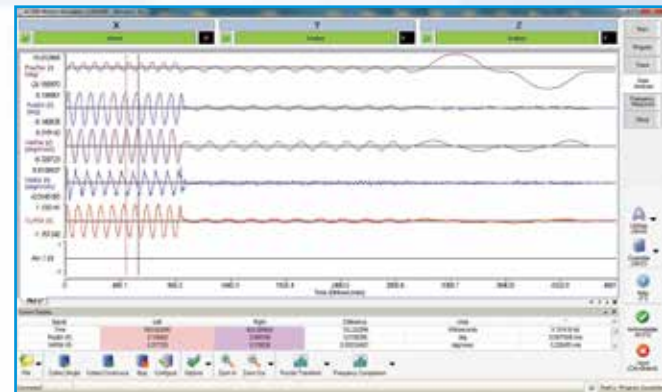
Program



Frequency Response



Track screen allows external signal selection for tracking

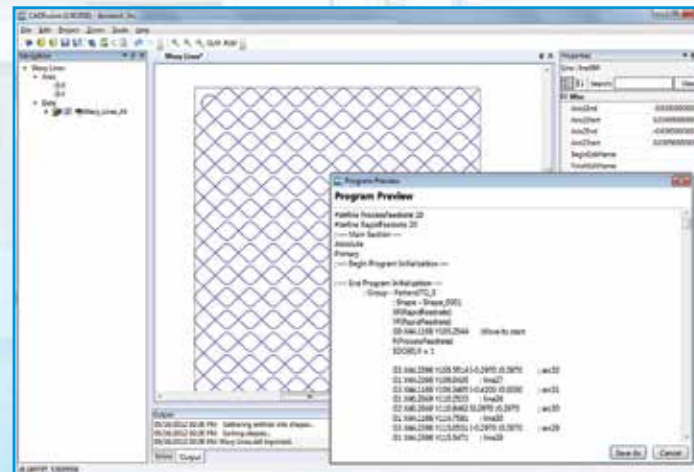
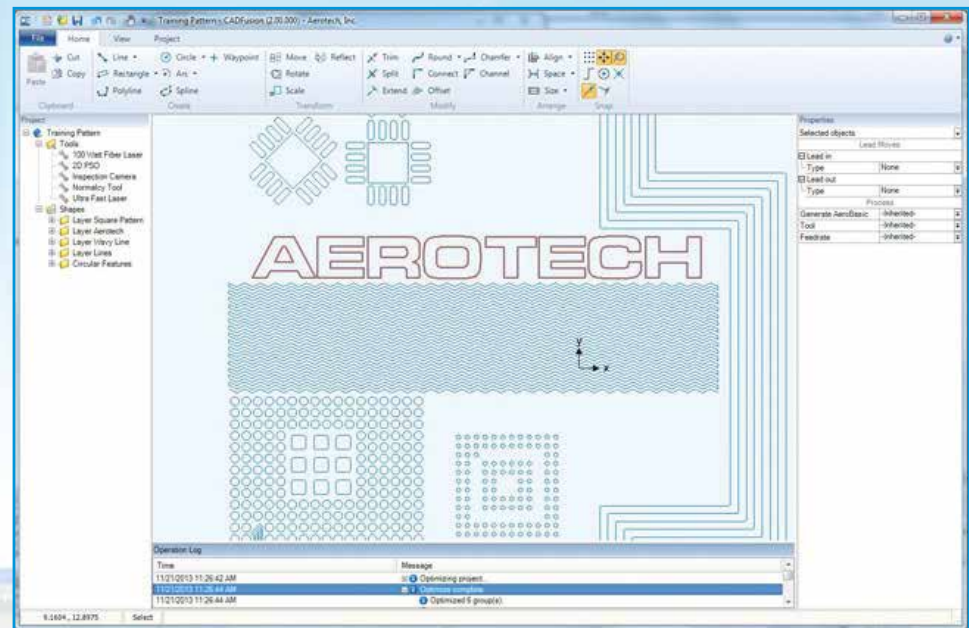


Data Analysis

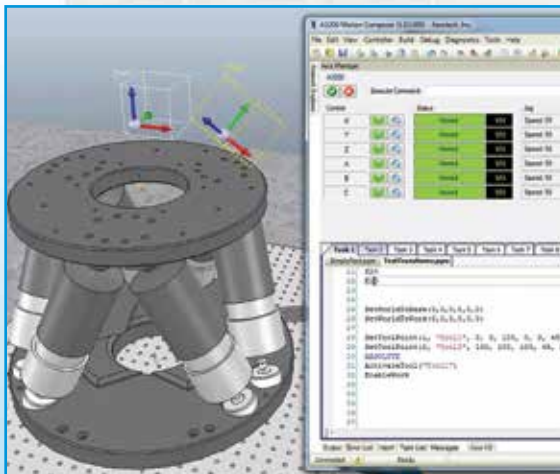
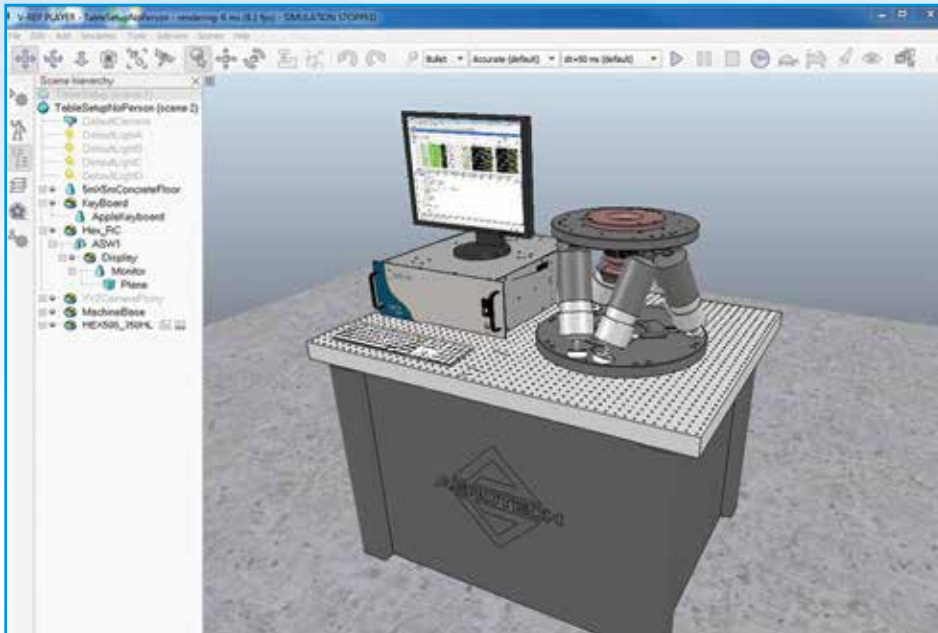
# CAD Fusion™

- 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



# Open Simulation Environment



# 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\*

## Configurable Operator Interface

The screenshot shows the Aerotech A3100 CNC Operator Interface software. It features a top status bar with axis positions (X, Y, Z, U, A) and velocity feedback. Below this is a 'Program Status Feedback' table and a 'Velocity Feedback' table. The main interface includes a 'Execute Task Command' section with a dropdown menu, a 'Run Mode' section with 'Auto' and 'Change' buttons, and a 'Configuration' section with 'Jog Pad', 'Velocity', and 'Jog Type' settings. A 'Program' window displays G-code, and a 'Buttons' section contains several customizable buttons. Callouts point to various elements: 'Issue immediate commands' points to the 'Execute Task Command' dropdown; 'Configurable axis manager' points to the axis status bar; 'Configurable jog pad' points to the 'Jog Pad' section; 'User customizable buttons' points to the 'Buttons' section; 'Active program' points to the 'Program' window; 'Standard machine controls' points to the 'Run Mode' section; 'Designed for touch screen' points to the 'Jog Pad' section; and 'Set up simple or complex action – user can attach a standard G-code program to a button' points to one of the customizable buttons.

Issue immediate commands

Configurable axis manager

Configurable jog pad

User customizable buttons

Active program

Standard machine controls

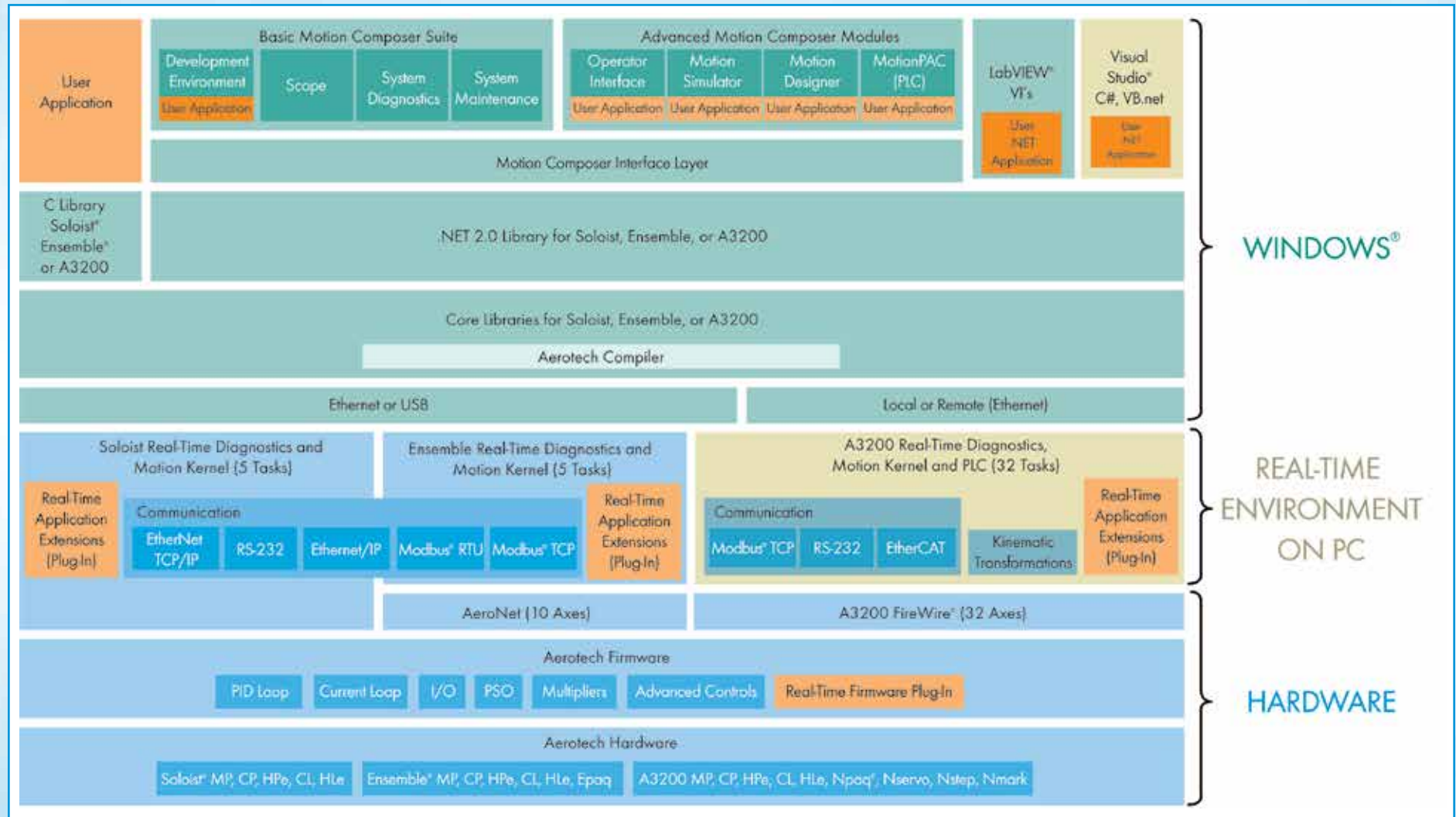
Designed for touch screen

Set up simple or complex action – user can attach a standard G-code program to a button



# Advanced Software Architecture

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





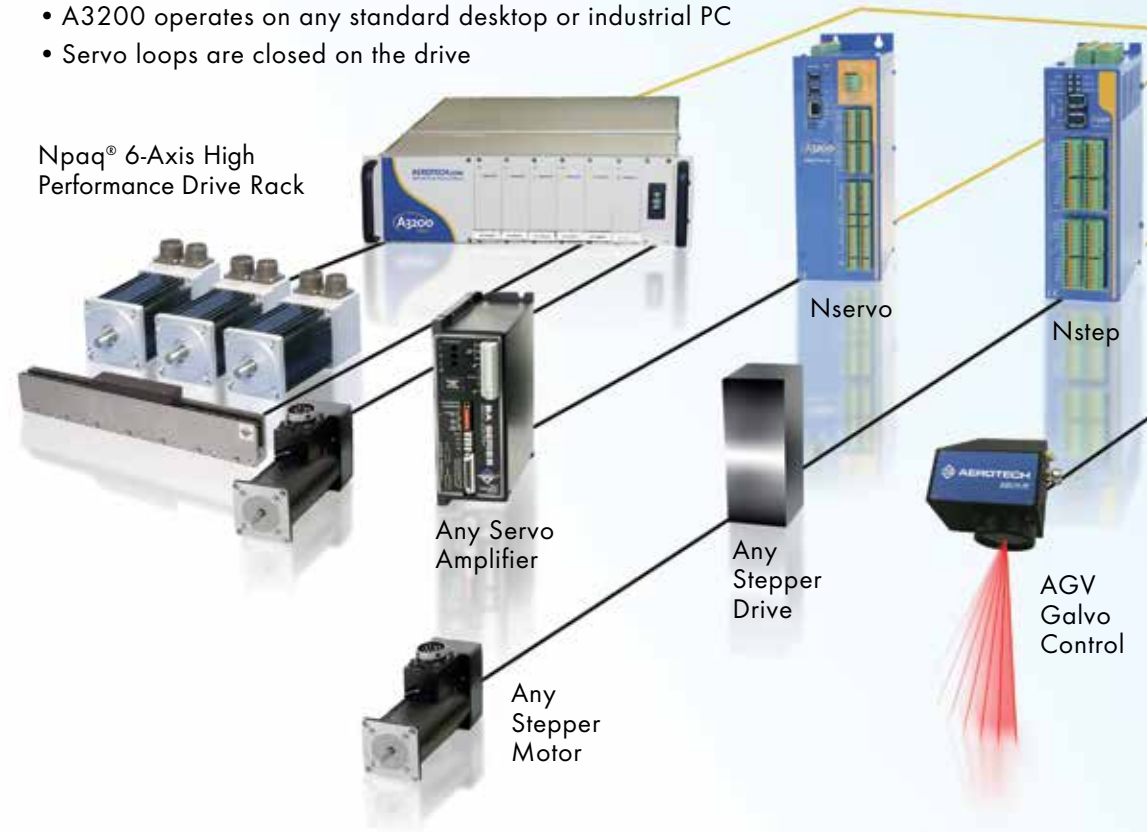
# Digital Automation Platform

- 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

Use Nservo to Retrofit Existing Motors & Drives or Drive Large Motors



# 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

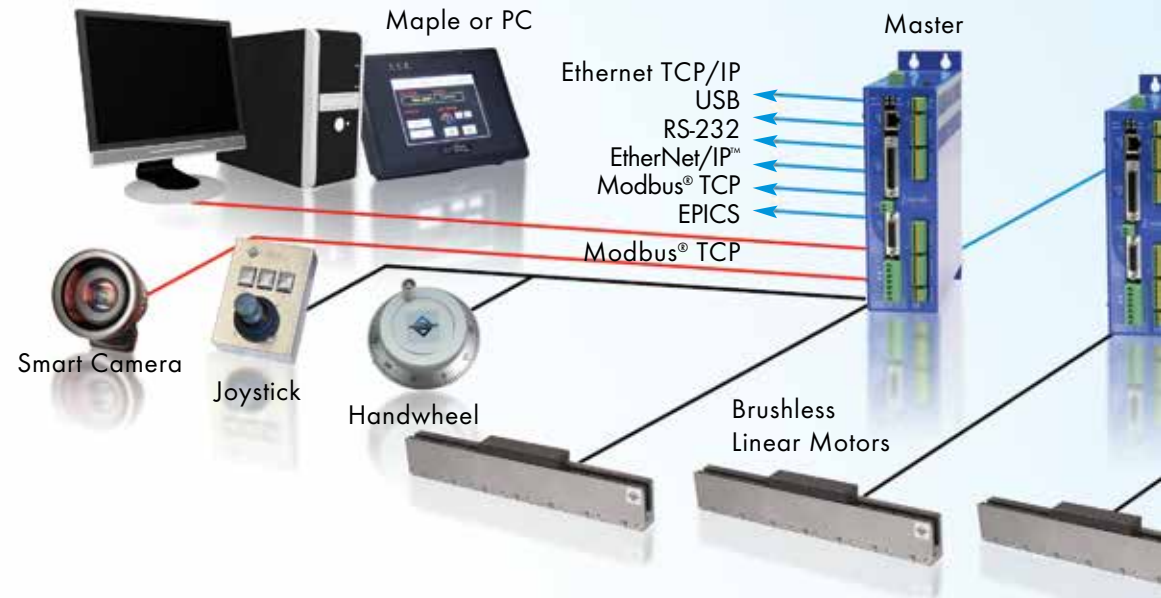


Ethernet I/O Expansion  
Analog and Discrete I/O

# Ensemble<sup>®</sup>

## 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



# 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



### Applications

- Semiconductor
- Medical
- Test and Inspection
- Packaging

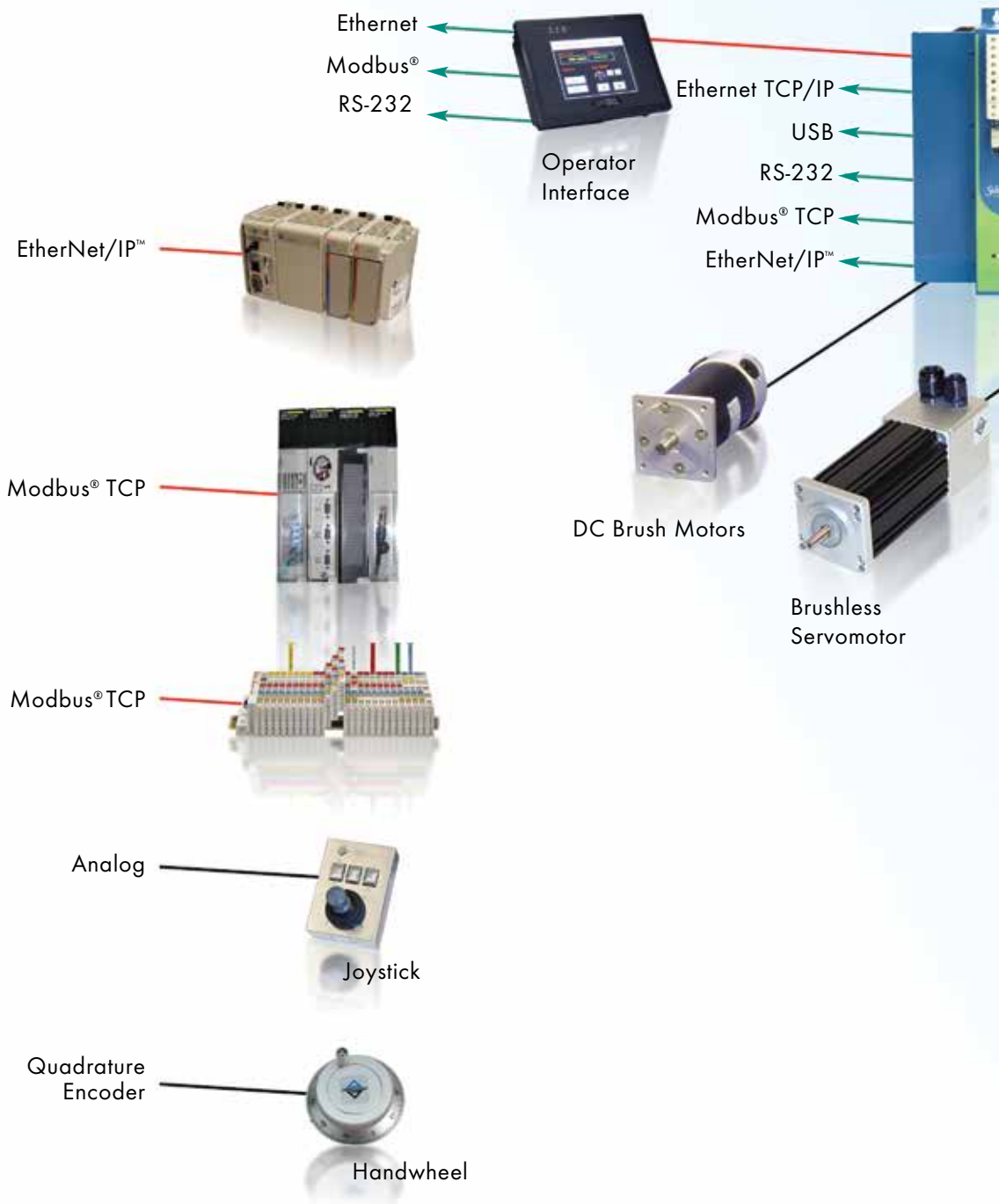
### Capability

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

*Soloist*<sup>®</sup>

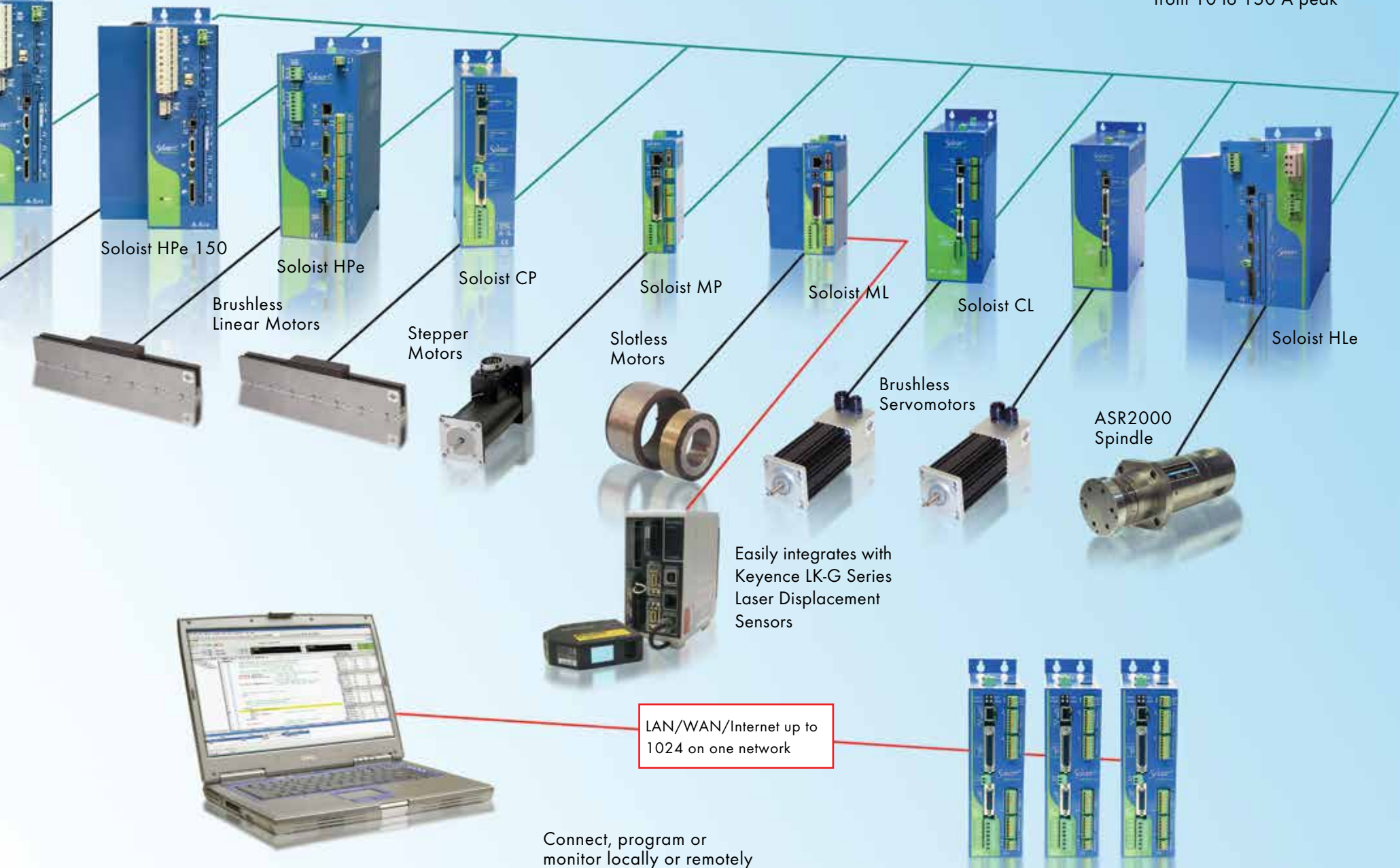
# Stand-Alone Single-Axis Automation Controller

- Easy to use
- Scalable
- Ethernet/USB connectivity



# Software, Controls, Drives and I/O in One Compact Package

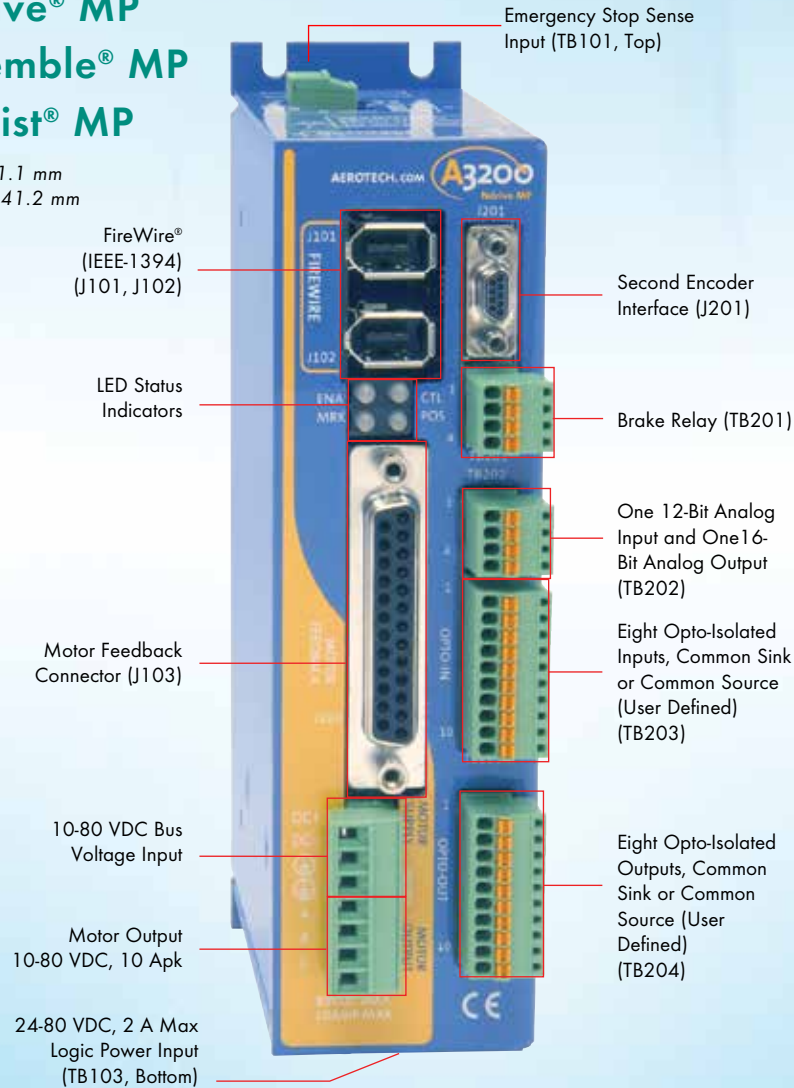
from 10 to 150 A peak



# Controller and Drive Technology

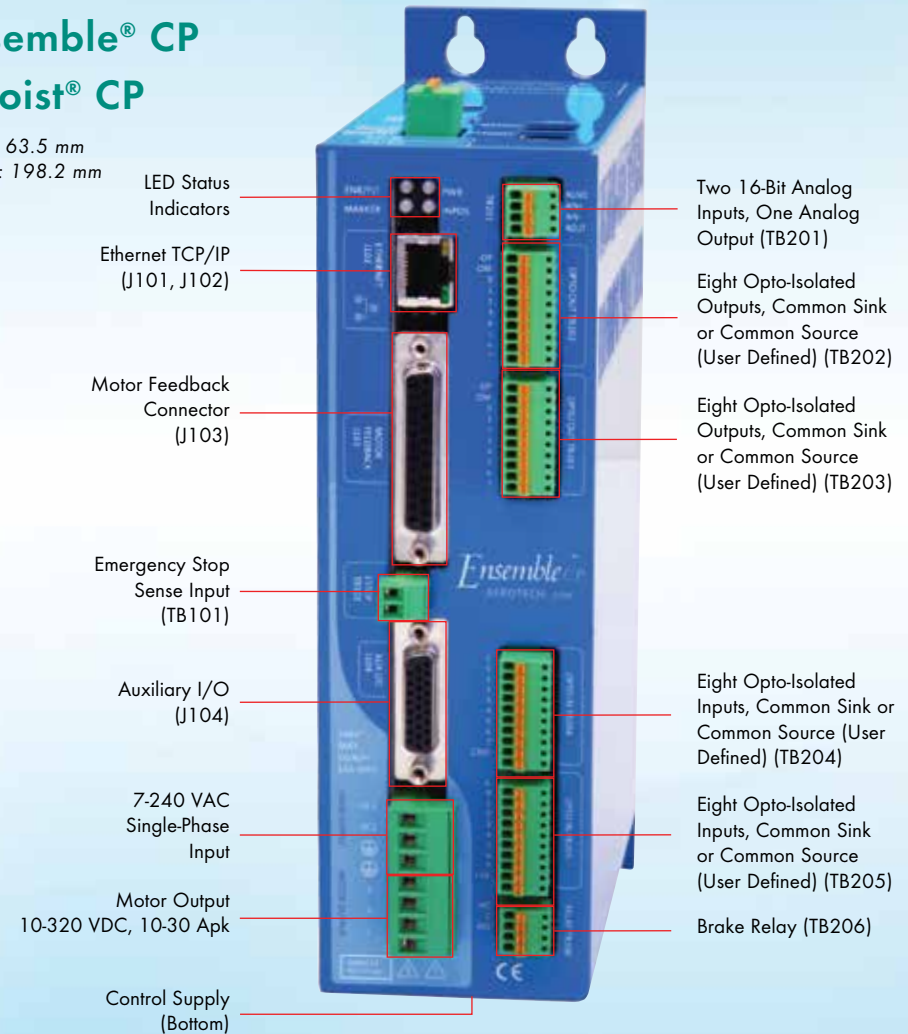
## Ndrive® MP Ensemble® MP Soloist® MP

Width: 41.1 mm  
Height: 141.2 mm



## Ndrive® CP Ensemble® CP Soloist® CP

Width: 63.5 mm  
Height: 198.2 mm





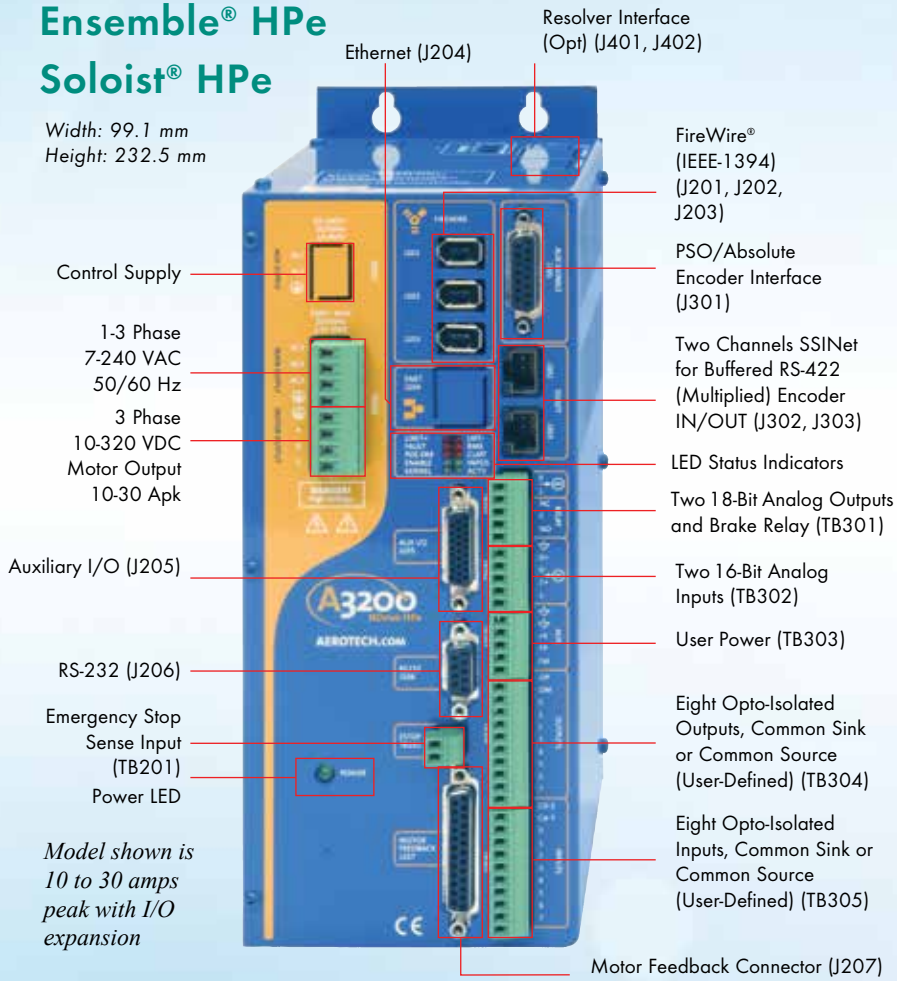
• MP for OEMs lowers costs

• CP solutions for less integration work

• HPe for the highest performance solution

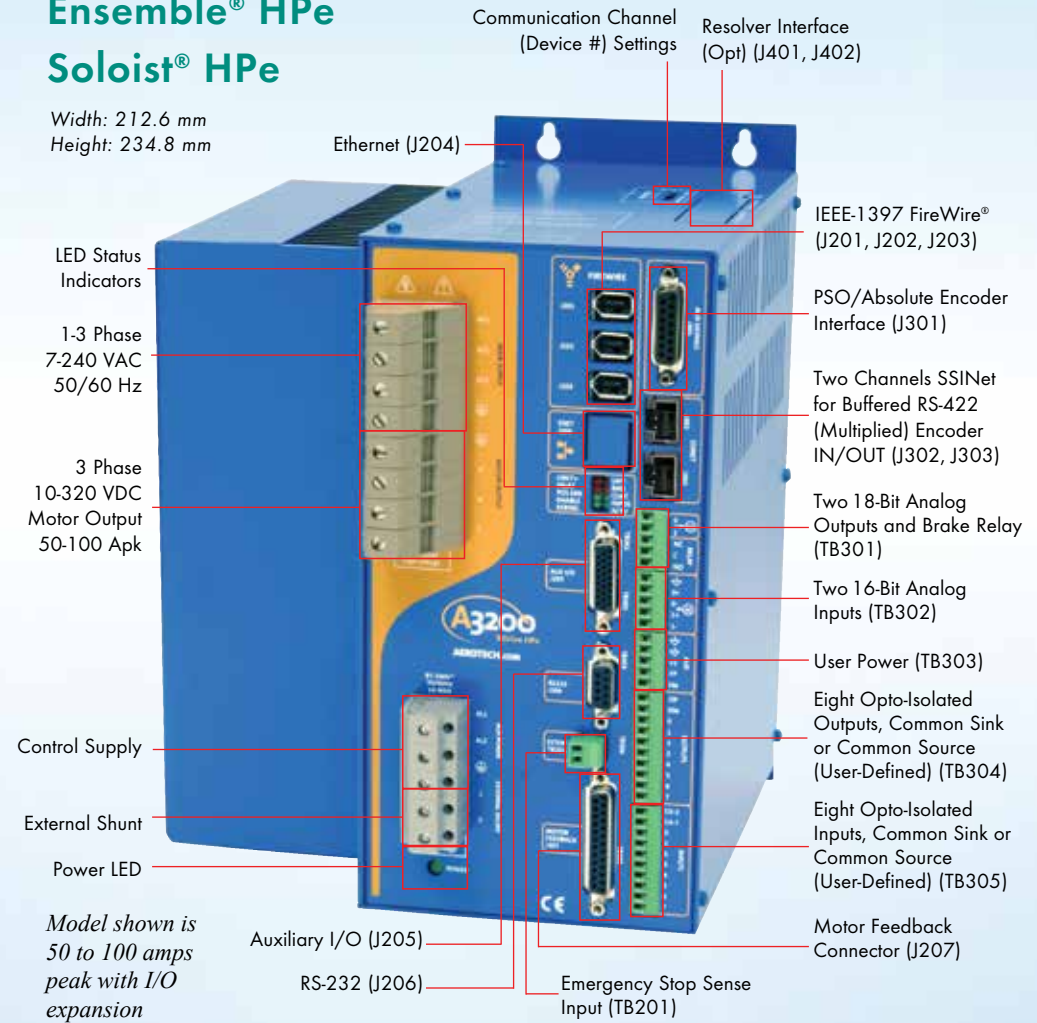
**Ndrive® HPe**  
**Ensemble® HPe**  
**Soloist® HPe**

Width: 99.1 mm  
Height: 232.5 mm



**Ndrive® HPe**  
**Ensemble® HPe**  
**Soloist® HPe**

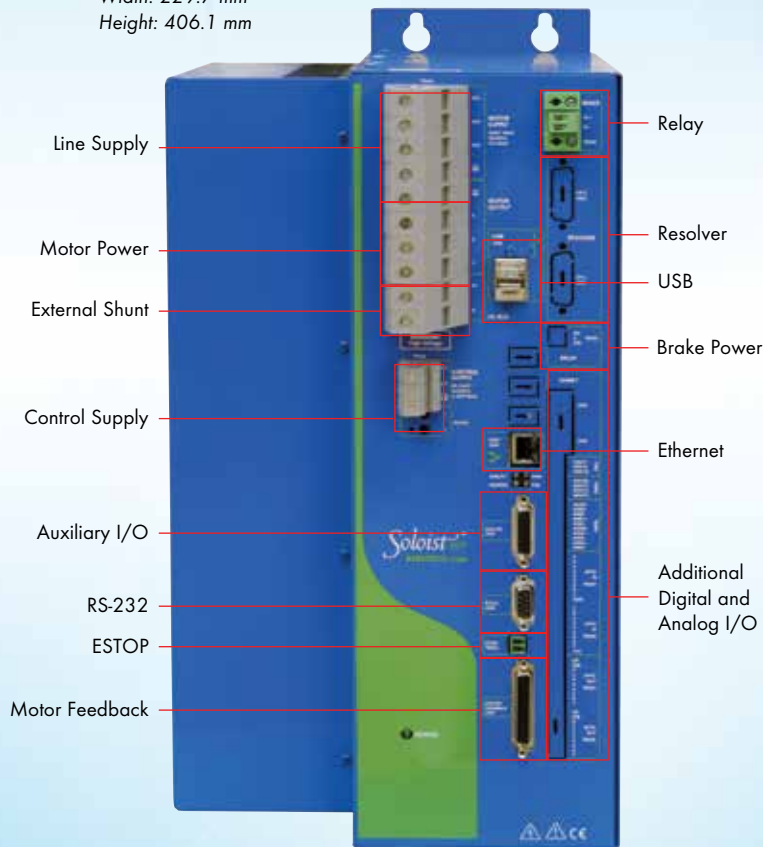
Width: 212.6 mm  
Height: 234.8 mm



# Controller and Drive Technology

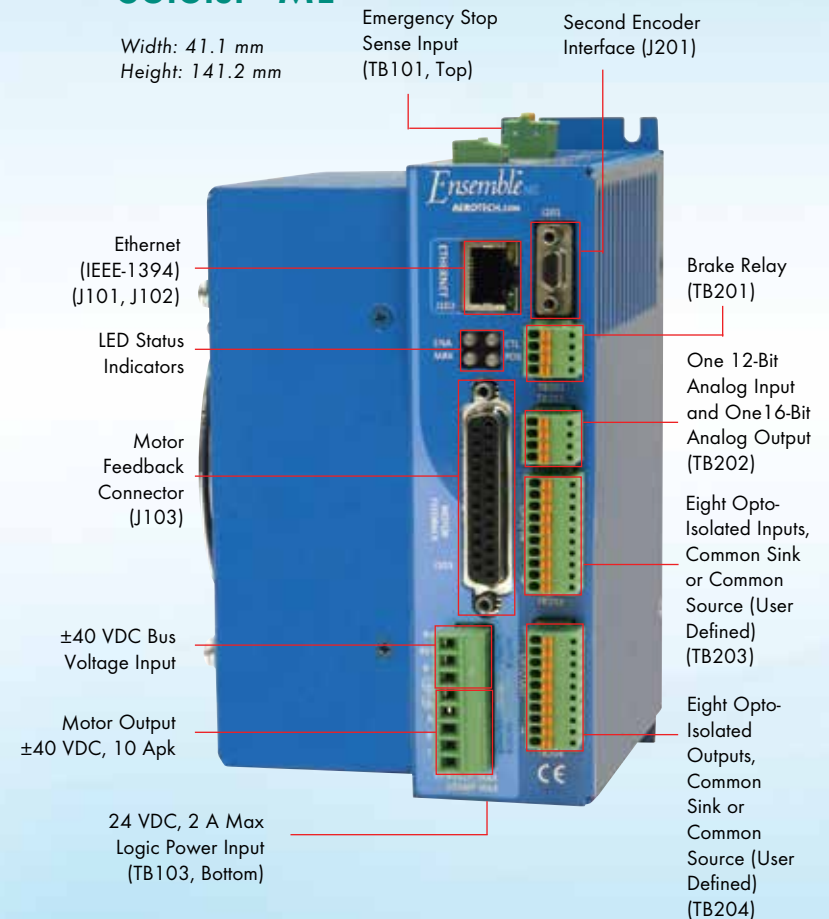
## Ndrive® HPe150 Ensemble® HPe150 Soloist® HPe150

Width: 229.7 mm  
Height: 406.1 mm



## Ndrive® ML Ensemble® ML Soloist® ML

Width: 41.1 mm  
Height: 141.2 mm



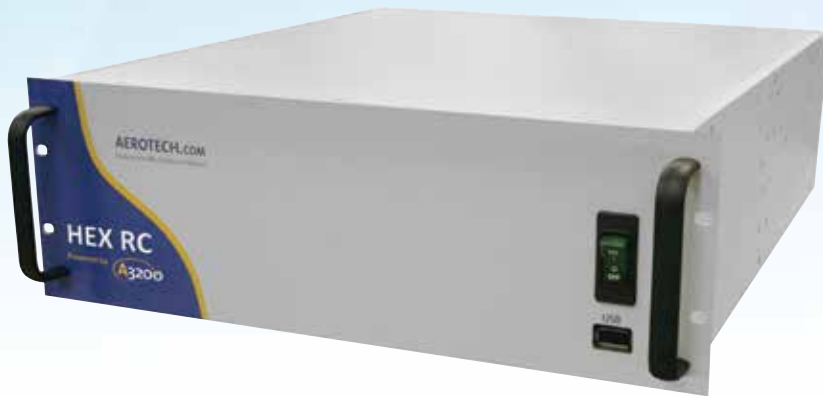
## Linear Drive Advantages

- 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

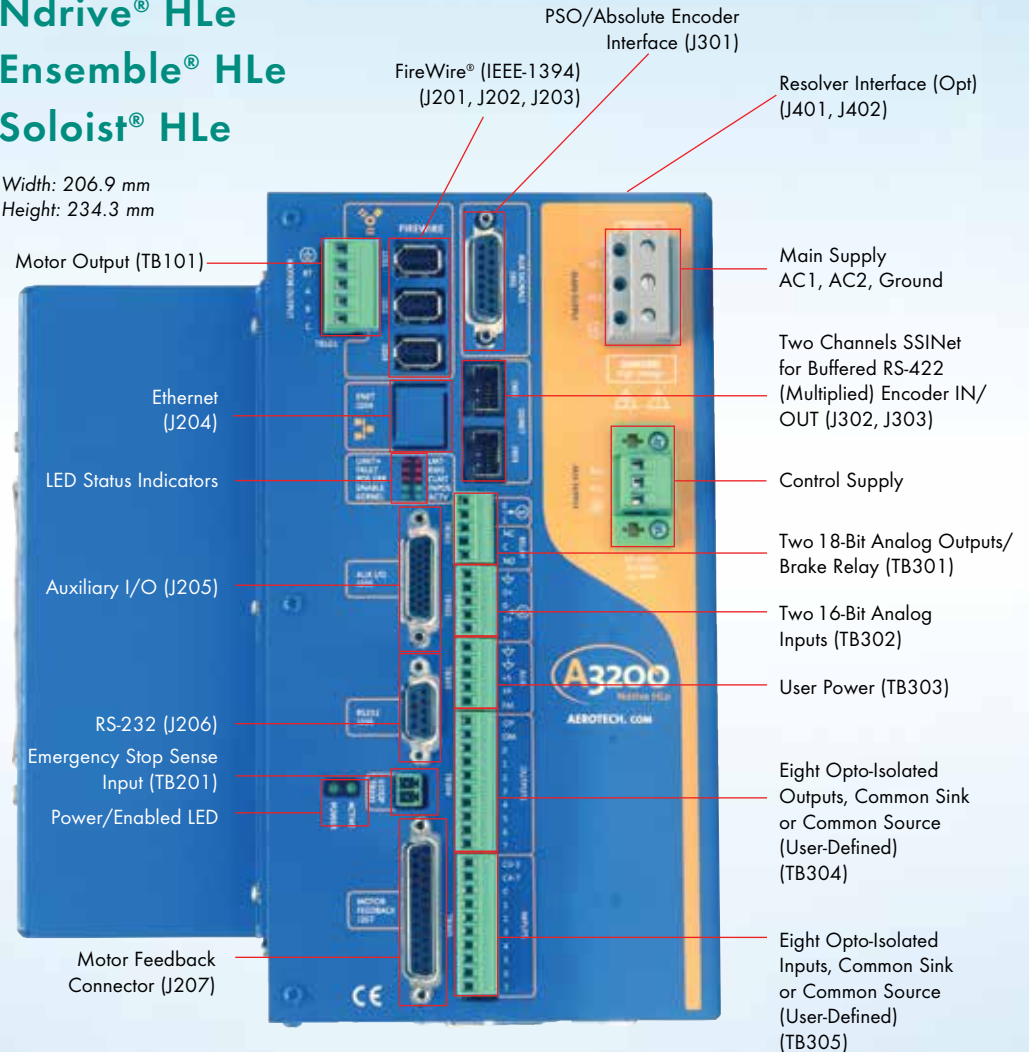


## Product Features - Standard

- 4U tall rack mount
- PC
  - Intel i&, 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,  $\pm 10$  V 12-bit differential
  - Analog Outputs - 2,  $\pm 5$  V, 16-bit

## Ndrive® HLe Ensemble® HLe Soloist® HLe

Width: 206.9 mm  
Height: 234.3 mm



# Controller and Drive Technology

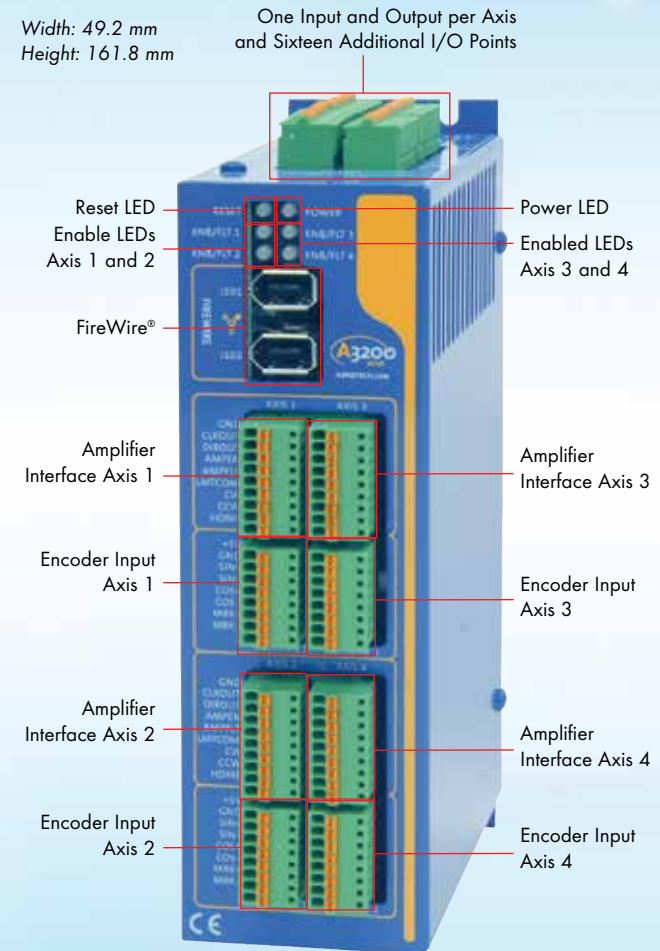
## Nmark™ CLS

Width: 90.5 mm  
Height: 210.8 mm



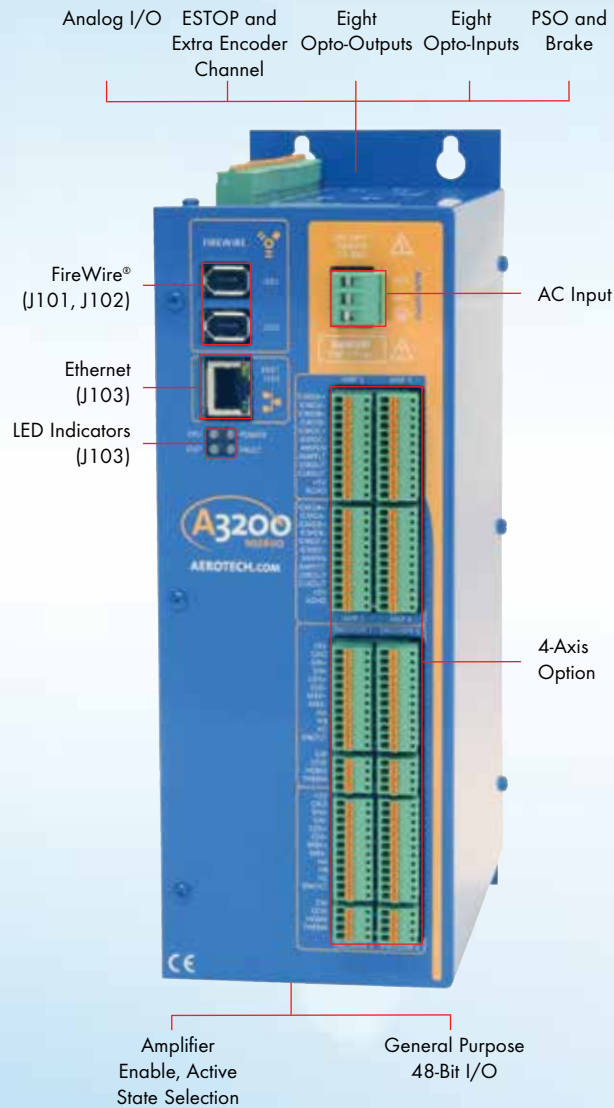
## Nstep

Width: 49.2 mm  
Height: 161.8 mm



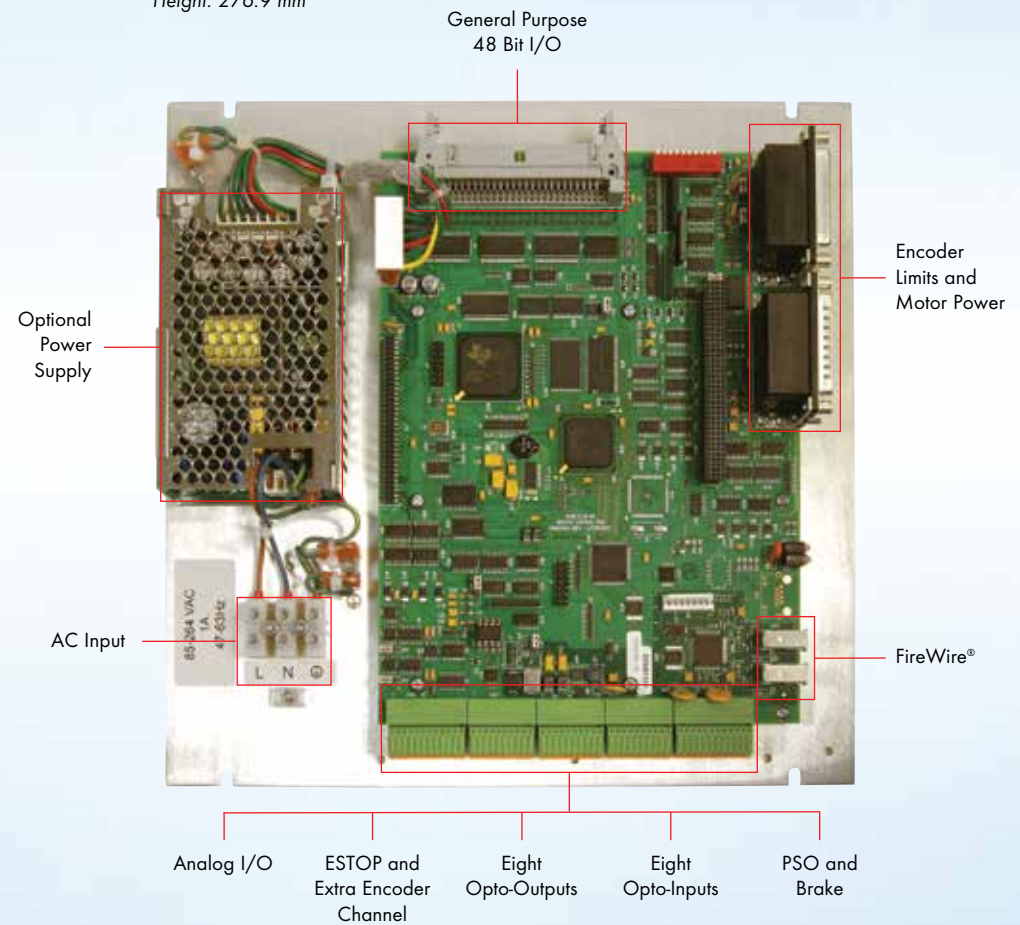
## Nservo

Width: 87.6 mm  
Height: 230.4 mm



## Nservo - OEM

4 Axis or Less  
Width: 284.5 mm  
Height: 276.9 mm



# Controller and Drive Technology

## Console



## Npaq®

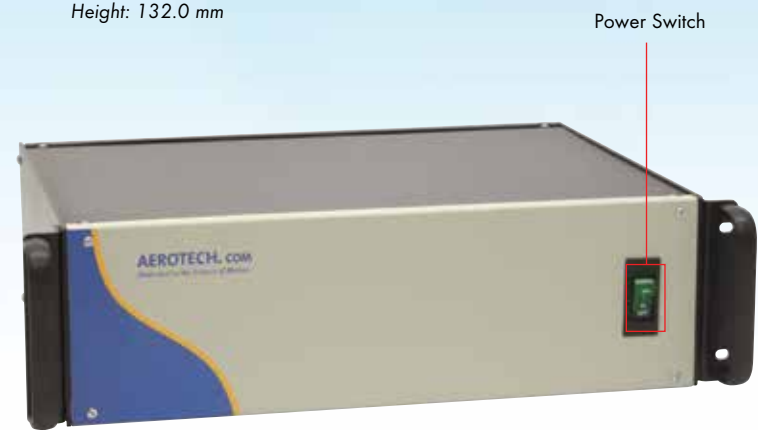
6 Axis or Less  
Width: 436.7 mm  
Height: 132.0 mm



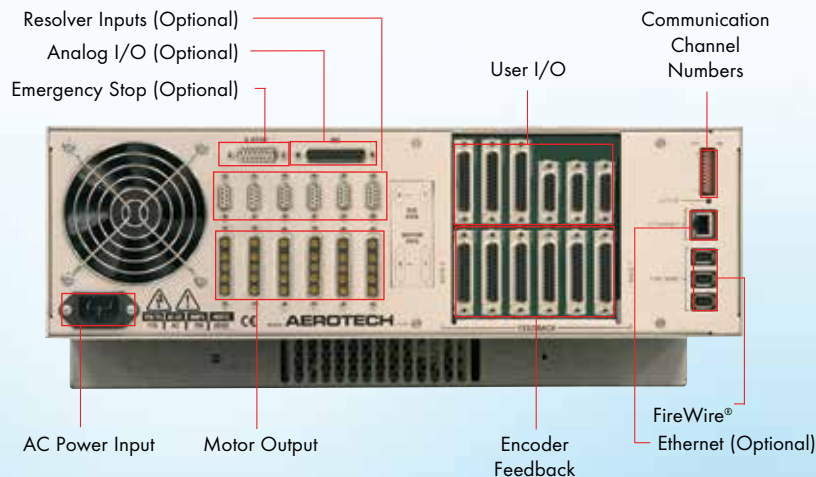
Laser Feedback (Optional)  
Power Switch/ Circuit Breaker

## Npaq® MR/Epaq MR

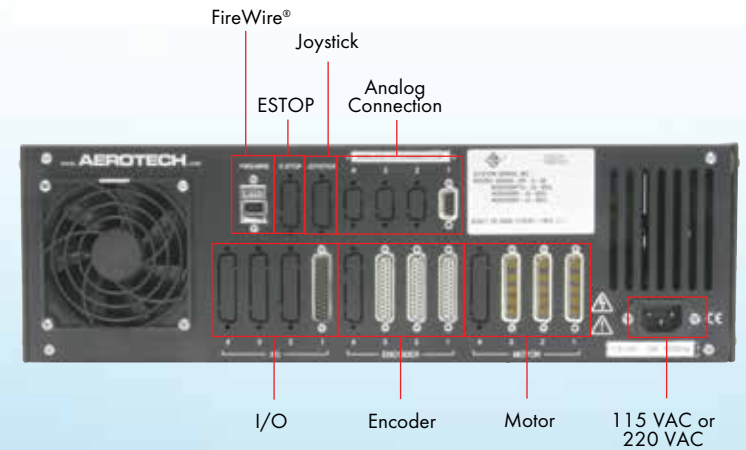
8 Axis or Less  
Width: 436.7 mm  
Height: 132.0 mm



Power Switch



Resolver Inputs (Optional)  
Analog I/O (Optional)  
Emergency Stop (Optional)  
AC Power Input  
Motor Output  
Encoder Feedback  
User I/O  
FireWire® Ethernet (Optional)  
Communication Channel Numbers

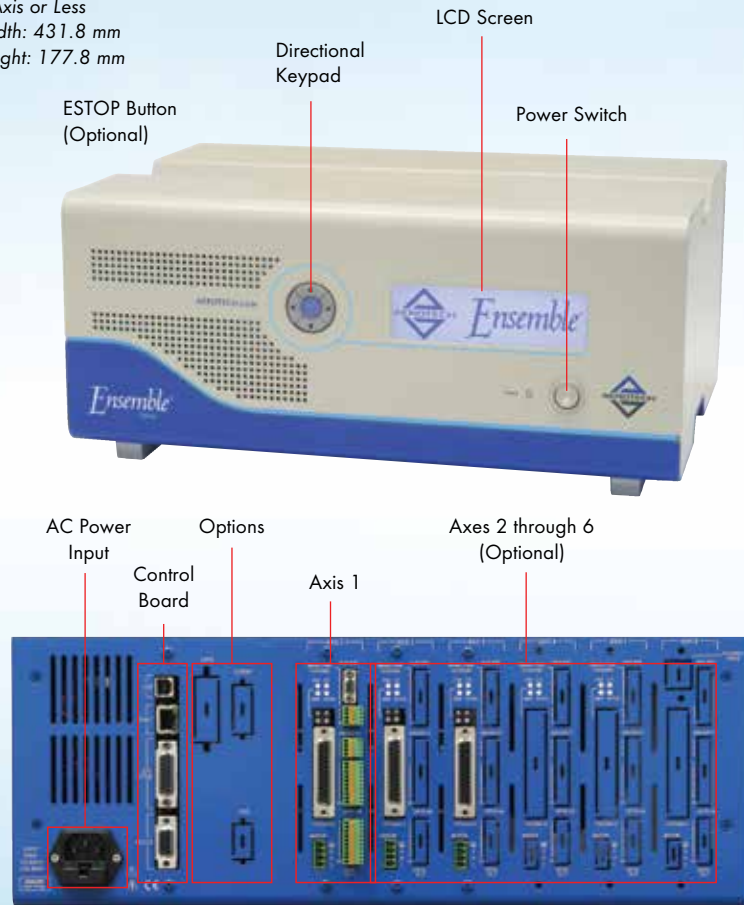


FireWire®  
Joystick  
ESTOP  
Analog Connection  
I/O  
Encoder  
Motor  
115 VAC or 220 VAC

# Npaq<sup>®</sup> and Epaq Rack Mount or Desktop Solutions in One Box Minimize Wiring

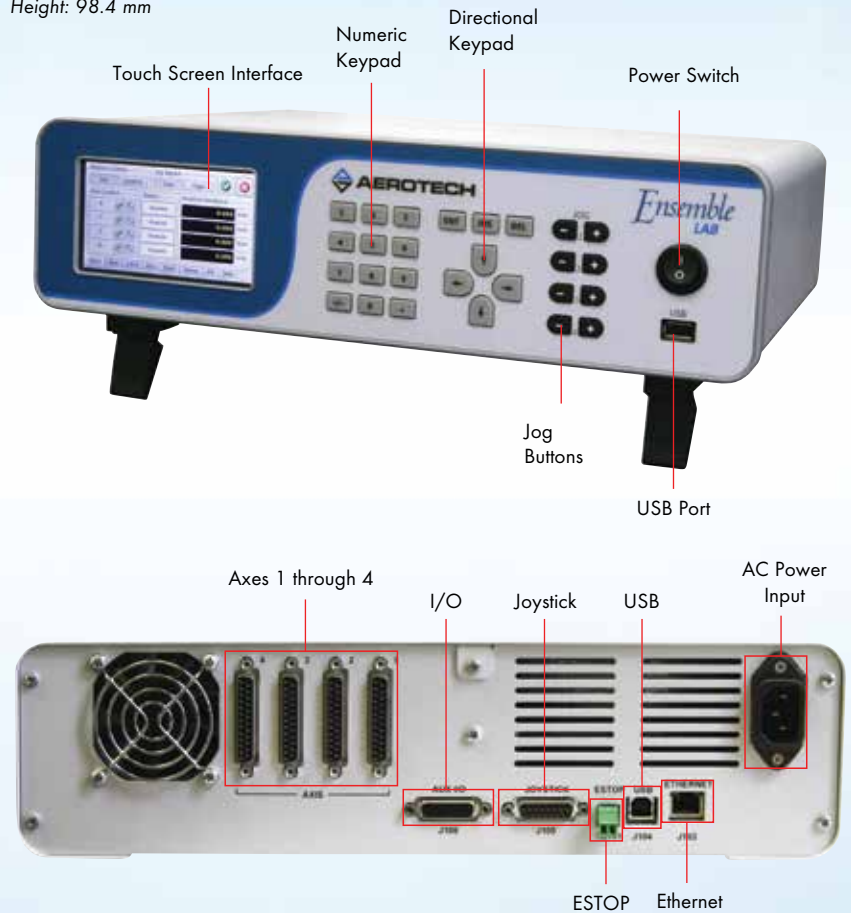
## Ensemble<sup>®</sup> Epaq

5 Axis or Less  
Width: 431.8 mm  
Height: 177.8 mm



## Ensemble<sup>®</sup> LAB

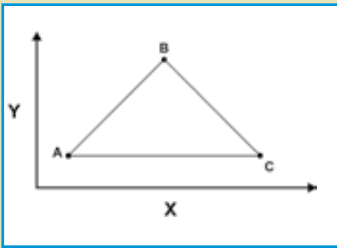
4 Axis or Less  
Width: 370.2 mm  
Height: 98.4 mm



# Standard Control Capabilities

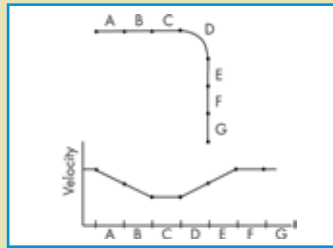
## Point-to-Point Motion

Basic independent axis positioning with programmable accel/decel and feedrate.



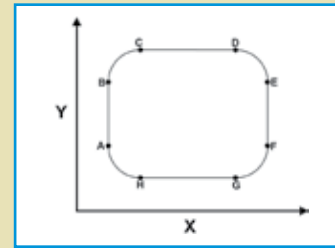
## Acceleration Limiting

Anticipate sharp corners and small radius arcs and automatically decelerate as needed.



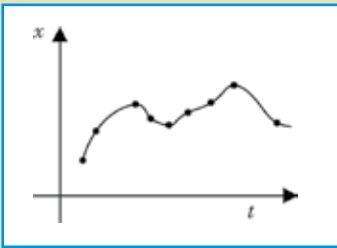
## Coordinated Motion

Linear and circular motions are supported in all languages.



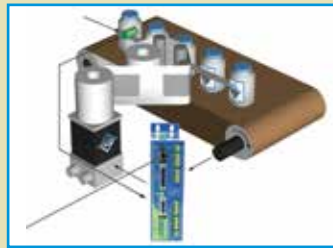
## Arbitrary Path Generation (PVT)

Specify discrete position, velocity and time and the controller will interpolate to create a smooth, contiguous path.



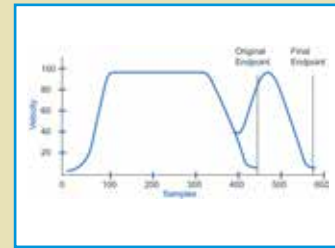
## Electronic Gearing

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.



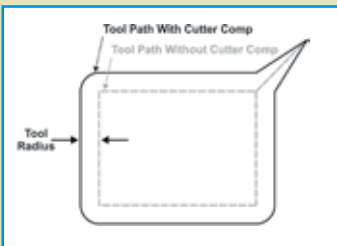
## On the Fly End-Point Modification

Modify the endpoint during execution of the motion profile.



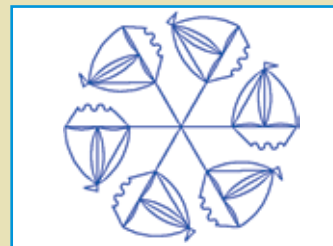
## Cutter Compensation

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



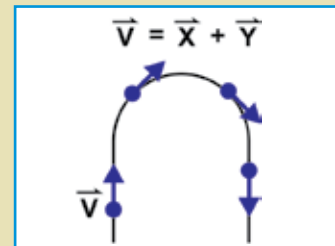
## Parts Rotation

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



## Velocity Profiling

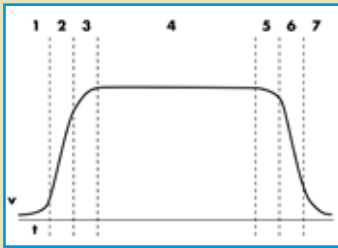
Maintains a constant vector velocity along the programmed path.





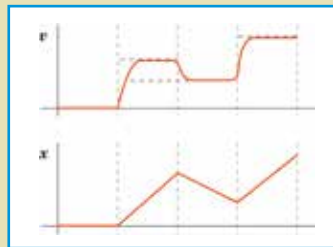
Aerotech controllers offer the broadest array of programming interfaces and core motion capabilities of any automation system available today. Aerotech controllers have the programming flexibility and capability to meet the requirements of the most demanding motion applications of OEMs and end-users alike.

### Seven Segment Acceleration



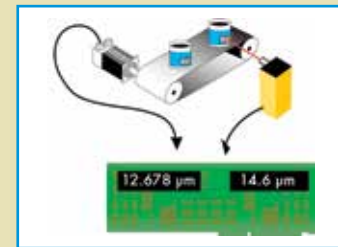
Specify the acceleration profile in seven segments, providing precise control over system motion.

### Velocity Blending



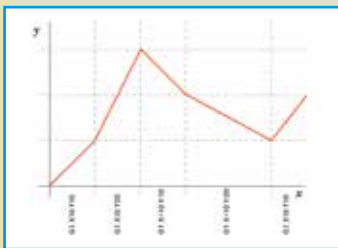
The velocity changes to the next velocity command, acceleration limited, without stopping.

### Fast Position Capture



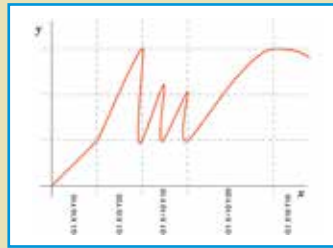
Store positions based on the transition of a digital input, allowing close correlation of axis positions to external events.

### Retrace



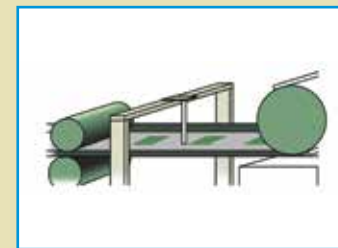
Retrace a path block by block.

### Intra-Block Retrace



Retrace a path inside a block.

### High-Speed Registration



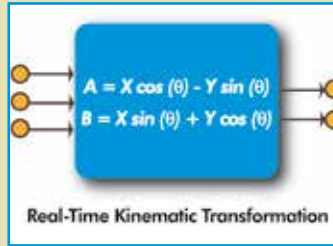
High-speed registration to trigger motion is useful in packaging and labeling.

### 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.

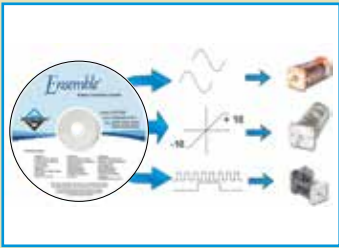
### Analog Power Control



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.

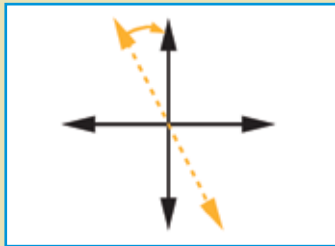
# Standard Control Capabilities

## Motor Control



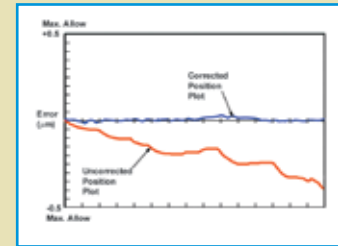
All controllers operate brush, brushless or stepper motors in any combination.

## Orthogonality Correction



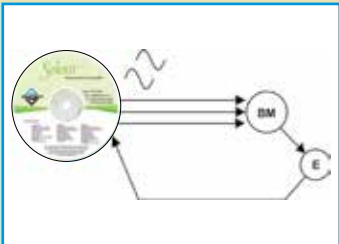
Improve X-Y planar accuracy by simply entering the known orthogonality error and the controller will compensate.

## Axis Calibration



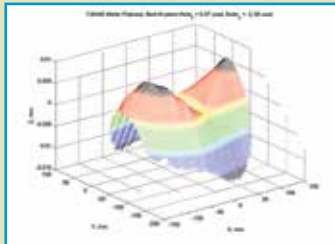
Compensate for repeatable mechanical errors in a positioning system.

## Sinusoidal Commutation



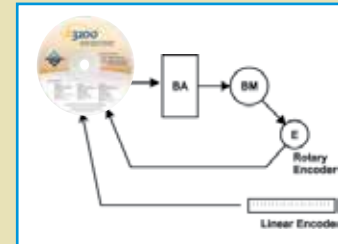
Brushless motors produce smoothest motion when sinusoidally commutated, eliminating the need for multiple transducers and reducing cabling.

## 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



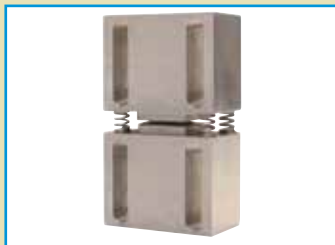
Dual-loop control is used to eliminate the effects of backlash and other sources of error.

## Quadrature Encoder



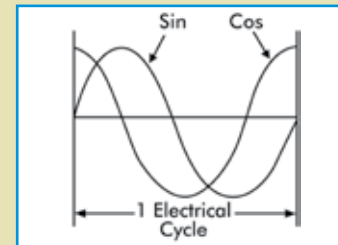
Use a standard A,B quadrature encoder, incremental or absolute.

## Analog Feedback



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

## Resolver/Inductosyn



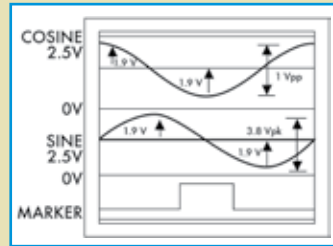
Programmable carrier frequencies make resolvers/inductosyns easy to integrate.

### Laser Interferometer



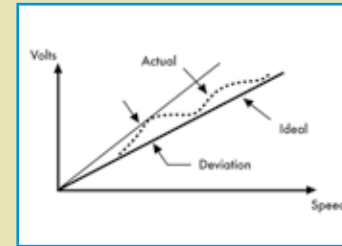
Systems requiring ultra-high resolution and feedback stability use interferometer feedback.

### Encoder



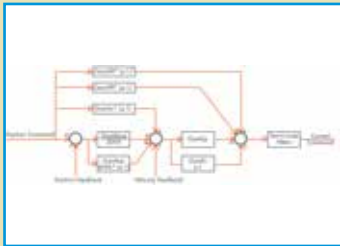
Systems requiring high resolution use a 1 V<sub>PP</sub> encoder with Aerotech multiplier, up to 65,536 and 2 MHz input frequency.

### Tachometer



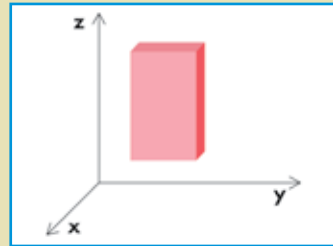
For dual feedback systems use tach for velocity control and encoder for position control.

### PIDFF



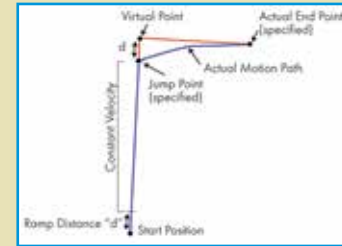
PID digital control loop with feedforward for velocity, acceleration and friction.

### 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



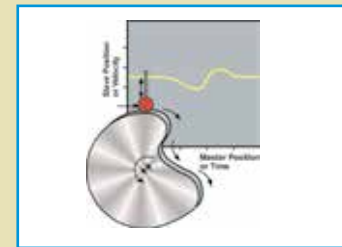
Set up hard limits and soft limits for maximum safety and flexibility.

### 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.

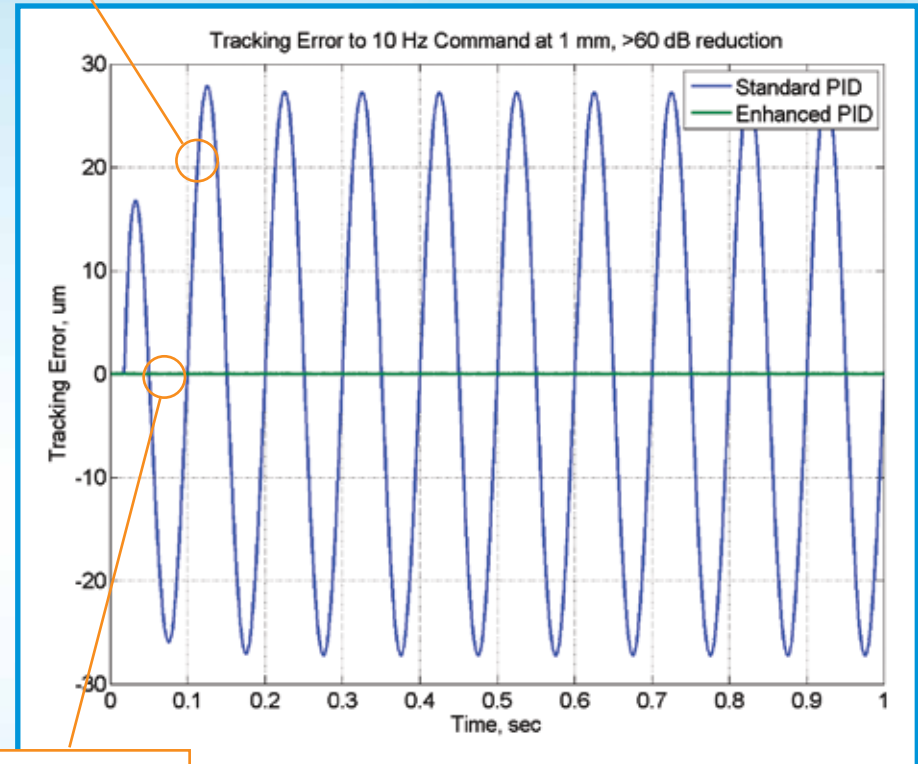
# Advanced Control: Harmonic Cancellation

- 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

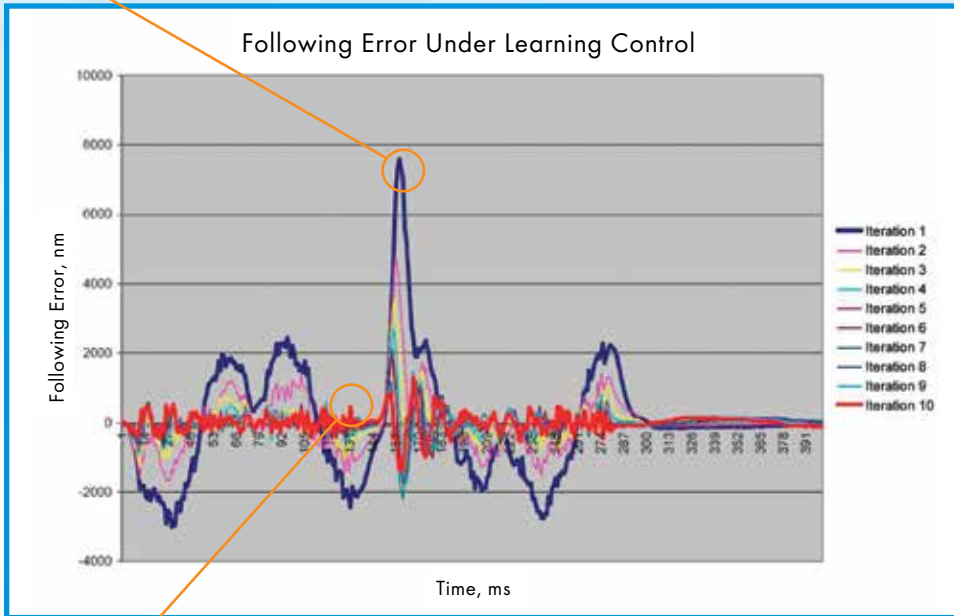
10 Hz Command;  $\pm 1$  mm

### Applications

- Machining
- Spindle Control
- Cogging Reduction
- EDM/ECM
- MEMS Sensor Testing
- R $\theta$  Wafer Inspection

# Advanced Control: Iterative Learning Control

1st Iteration



Final Iteration

## Applications

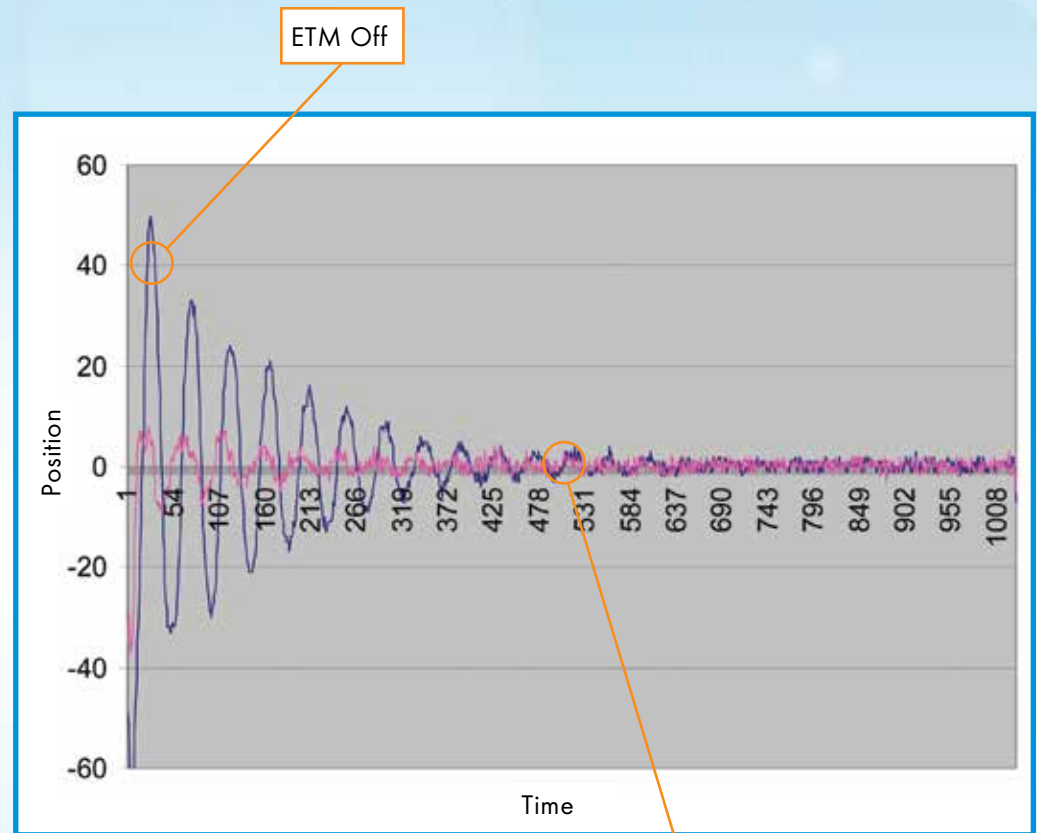
- Stencil Cutting
- Stent Cutting
- Sensor Testing
- Micromachining

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

# Advanced Control: Enhanced Throughput Module (ETM)

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

## Improved Settling Time

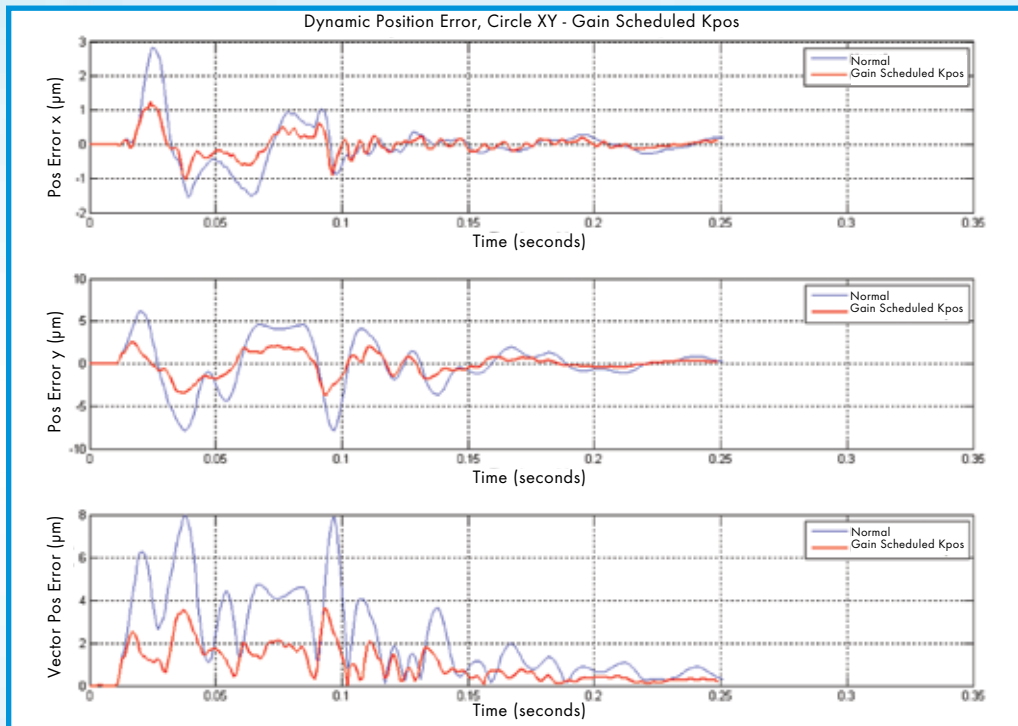


### Applications

- Pick and Place Machines
- Semiconductor Inspection
- Genome Sequencing

# Advanced Control: Directional Gain Scheduling

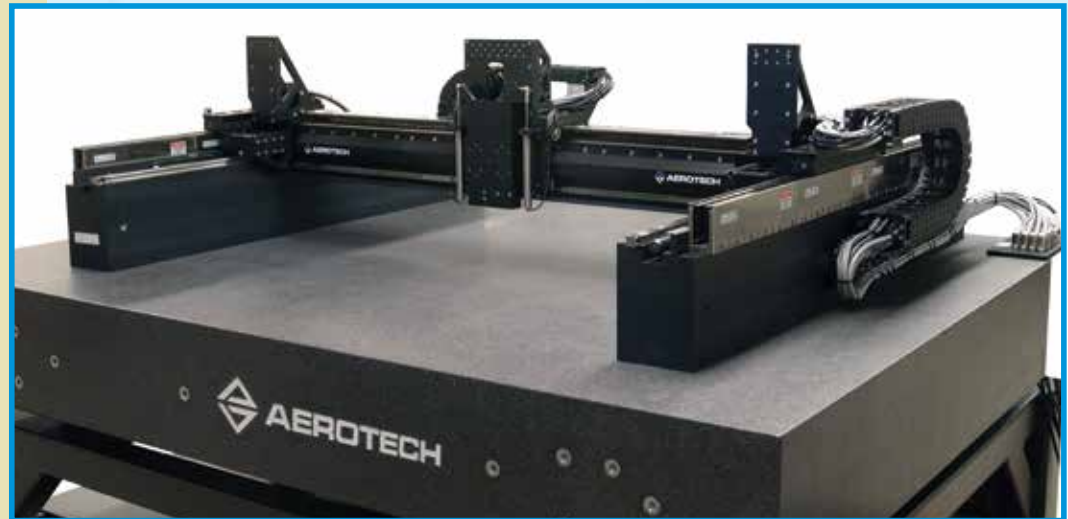
- Decrease settle time
- Increase in-position stability



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

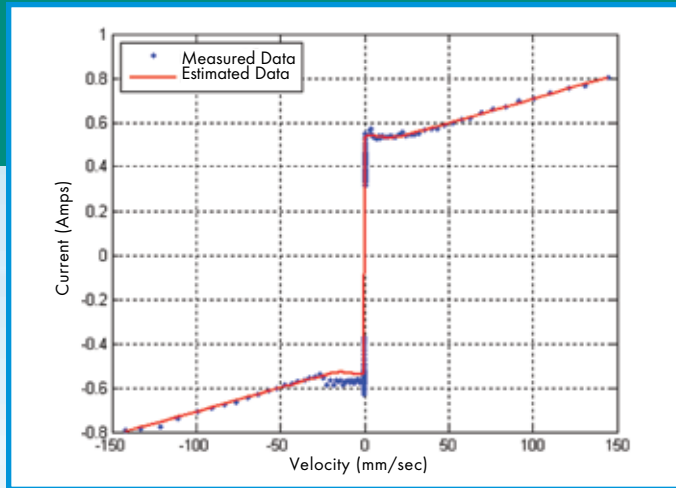
- Current Synchronization
- Position Synchronization

## Gantry Configuration

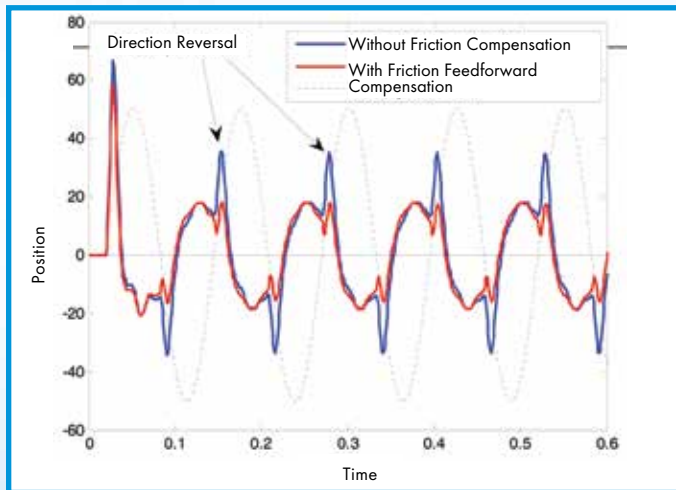
- 2 Motors, 2 Encoders
- 2 Motors, 1 Encoder
- 1 Motor, 1 Encoder



## Advanced Friction Model



## Friction Compensation Results



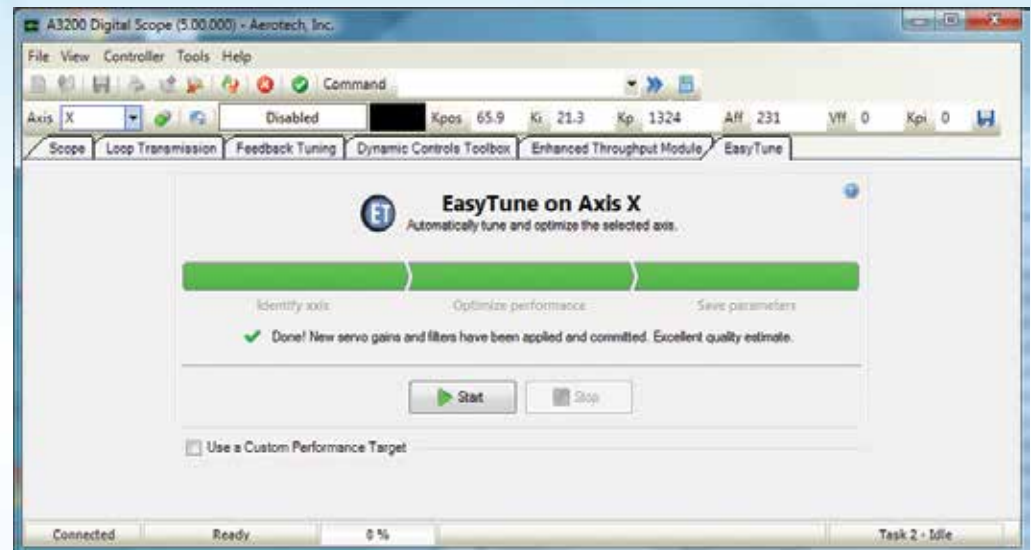
High speed, high accelerations and minimal position error achieved with feedforward additive force

# Advanced Control: Friction Compensation

- Reduced settle time
- Reduced error at direction reversals

# 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:



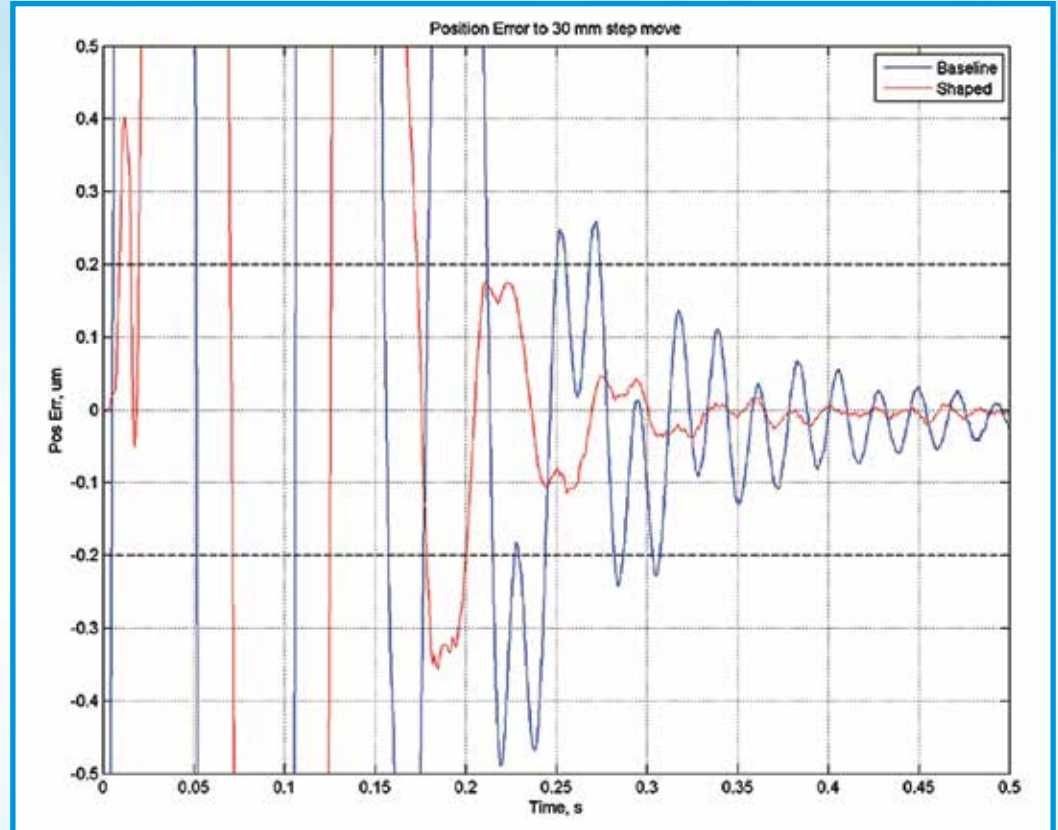
# Delta Robot Control

- 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

## Reduce Vibration at the Work Point



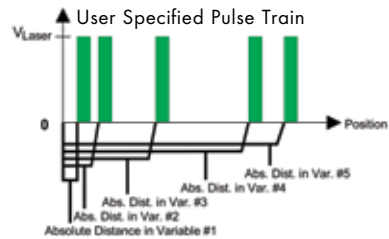
Position error at work point to 30 mm step move

### Applications

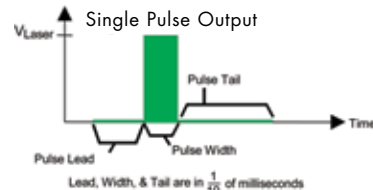
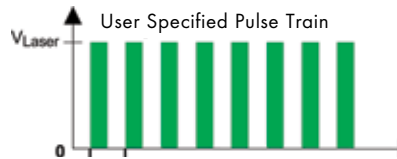
- Pick and Place Machines
- Semiconductor Inspection
- Genome Sequencing

# High Accuracy Firing Based on Actual Calibrated Encoder Counts

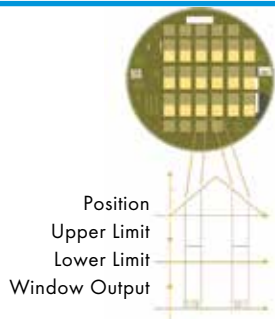
## Array-Based Firing



- 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

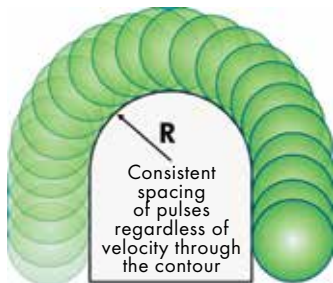


## Windowing



- 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: Position Synchronized Output (PSO)

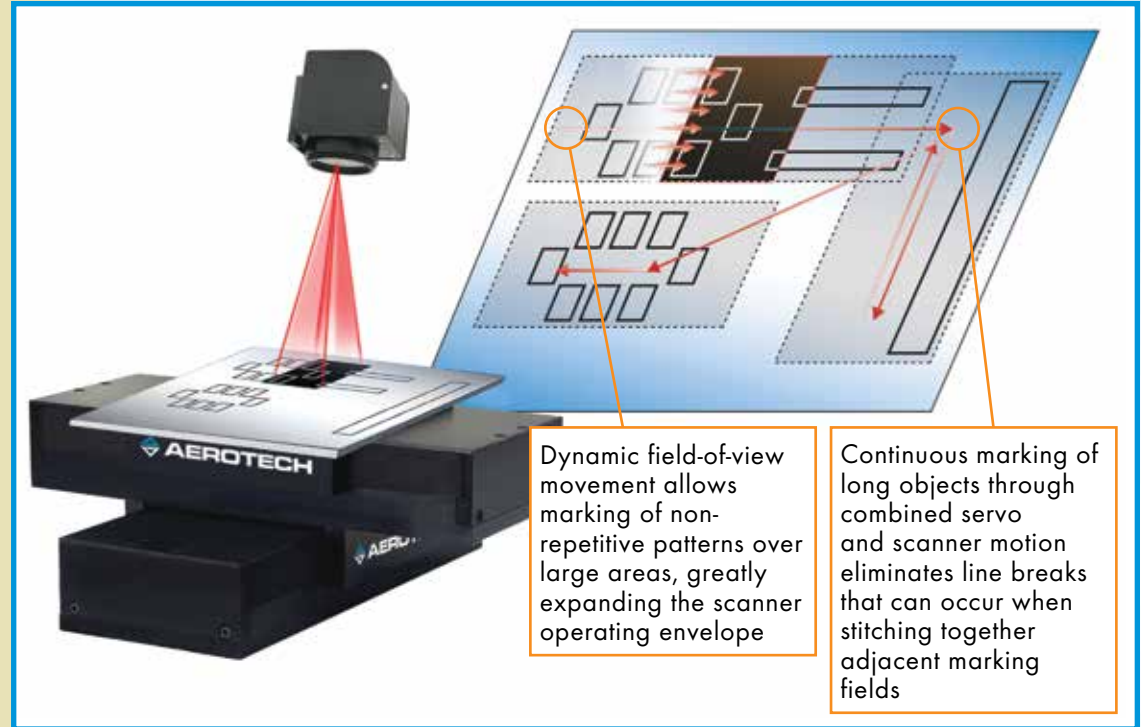
- Increase throughput
- Higher accuracy
- 1-, 2- or 3-axis PSO
- Configurable command pulse train
- Use to Trigger
  - Laser firing
  - Camera capture
  - Data acquisition
  - Nondestructive test triggering

# Advanced Control: Laser Marking Nmark<sup>®</sup> 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



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

# AGV Galvanometer



## AGV Specifications

Mechanical Specifications	AGV-10	AGV-14	AGV-20	AGV-14HP	AGV-20HP
Beam Aperture	10 mm	14 mm	20 mm	14 mm	20 mm
Resolution	12 $\mu$ rad			0.007 $\mu$ rad	
Marking Speed	3 m/s	2.5 m/s	1.5 m/s	2.5 m/s	1.5 m/s
Positioning Speed	12 m/s	9.5 m/s	4.5 m/s	9.5 m/s	4.5 m/s
Writing Speed	900 cps	700 cps	400 cps	700 cps	400 cps
Positioning Resolution	2 $\mu$ m			1.1 nm	
Positioning Repeatability	2.4 $\mu$ m	2 $\mu$ m	2 $\mu$ m	0.32 $\mu$ m	
Positioning Accuracy	<800 $\mu$ m (standard) <50 $\mu$ m (-PLUS option)			<30 $\mu$ m (standard) <10 $\mu$ m (-PLUS option)	

- 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

## Graphic Applications\*

- Bar Code
- Serialization
- Engraving
- Character Scribing

## Vector Applications

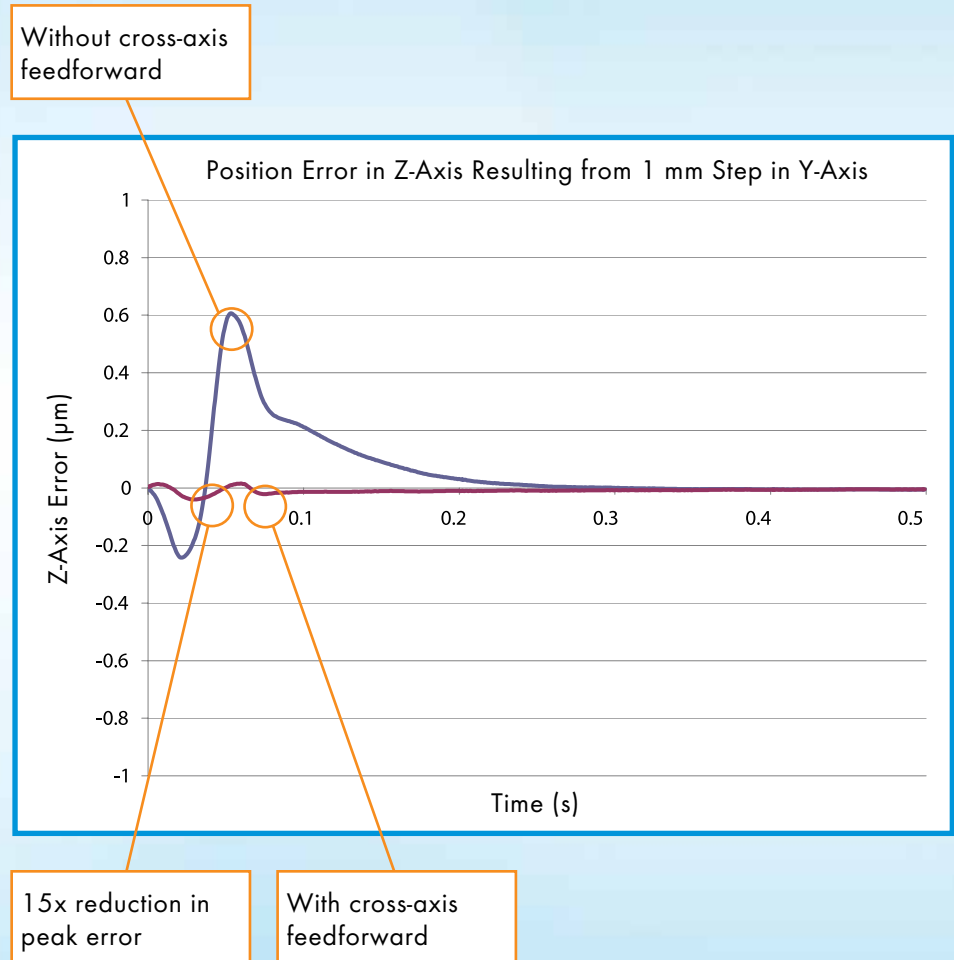
- Cutting
- Welding
- Sealing
- Ablation
- Marking

\*Coming Soon

# Advanced Control: Cross-Axis Feedforward

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

Reduce cross-axis position error during acceleration





# 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	Plant					Fieldbus						Motion		Drive I/O	
	Ethernet TCP/IP	USB	RS-232	RS-485	OPC*	EtherCAT	EtherNet/IP™	DeviceNet™*	CANopen*	PROFIBUS	Modbus® TCP	FireWire®	Aeronet	Analog	Digital
A3200	✓				✓	✓		✓	✓	✓		✓		✓	✓
Ensemble	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓
Soloist	✓	✓	✓	✓			✓	✓	✓	✓	✓			✓	✓
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.	

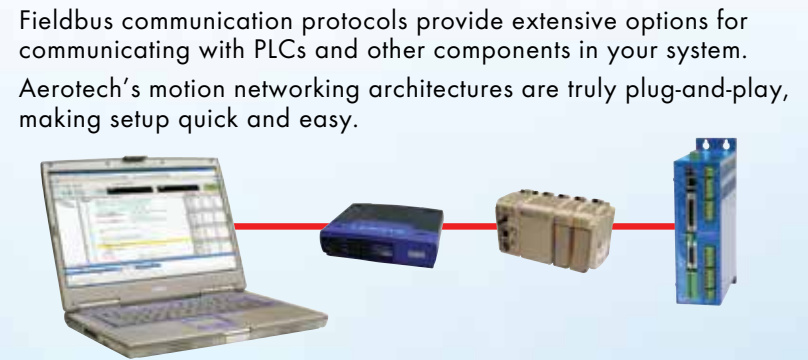
\*Coming Soon



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 highresolution 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.



# Piezo Controllers



## Ensemble QL/QLe

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.

## Ensemble QDe™

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.

## Ensemble QLAB

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.

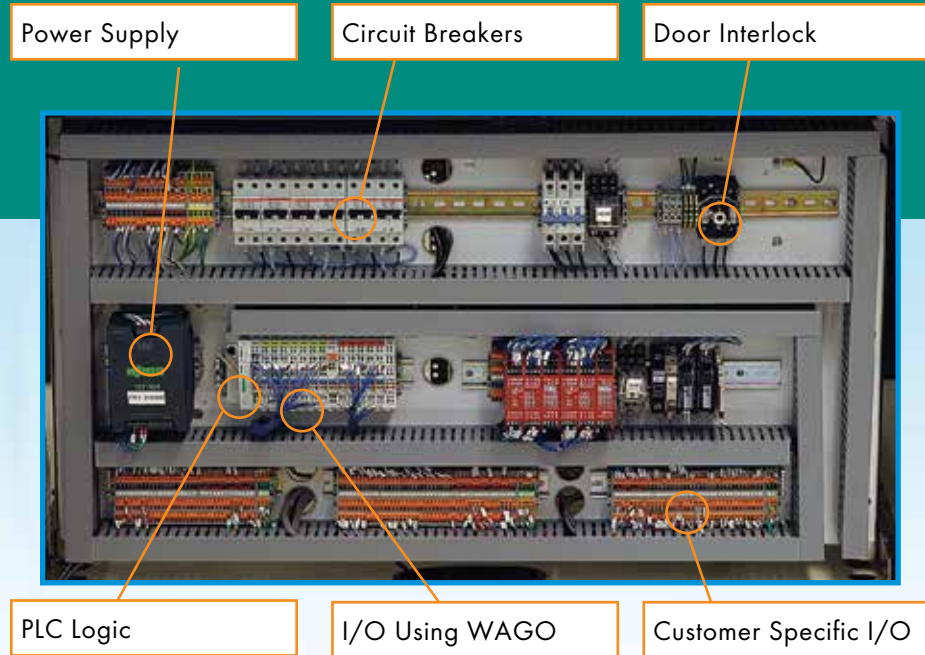
Basic Functions	A3200	Ensemble	Soloist
Multi-Axis	Up to 32 axes coordinated	Up to 10 axes coordinated	Single axis
Architecture	PC-based software controller	Stand-alone	Stand-alone
Number of Tasks	32	4	4
CNC Functionality/RS-274	✓		
Coordinated Motion	✓	✓	
Point-to-Point Motion	✓	✓	✓
Cutter Compensation	✓		
Multi-Block Look-Ahead	✓		
Acceleration Limiting/Look-Ahead	✓		
Gantry Mode	✓	✓	
Velocity Blending	✓	✓	✓
Electronic Gearing	✓	✓	✓
Electronic Cam Profiling	✓	✓	✓
Arbitrary Path Generation	✓	✓	✓
Jog and Offset, Jog and Return	✓		
Velocity Profiling	✓	✓	✓
Retrace (Block by Block)	✓		
Axis Calibration	✓	✓	✓
3D Error Mapping	✓		
Sinusoidal Commutation	✓	✓	✓
Analog Power Control	✓	✓	✓
Servo, Stepper or DC Motor Controller	✓	✓	✓
Expanded IO Available	✓	✓	✓
Encoder Tuning	✓	✓	✓
Dual Loop Control	✓	✓	✓
PLC (IEC 61131-3)	✓		

# Use the Best Controller for Your Application

Advanced Functions	A3200	Ensemble	Soloist
IDE	✓	✓	✓
.NET, AeroBasic™	✓	✓	✓
Fast Position Capture	✓	✓	✓
High-Speed Registration	✓	✓	✓
On the Fly End-Point Modification	✓	✓	✓
Orthogonality Correction	✓	✓	✓
Parts Rotation	✓		
Intra-Block Retrace	✓		
Iterative Learning Control	✓	✓	✓
PSO	Yes, up to 3 axes	Yes, up to 3 axes	Yes
Harmonic Cancellation	✓	✓	✓
Direction Gain Scheduling	✓	✓	✓
Inertial Damping	✓	✓	✓
Friction Compensation	✓		
Linear Drive Amplifiers	✓	✓	✓
Machine Retrofit Hardware Available	✓		
Galvo Integration	✓		
Seven Segment Acceleration Profile	✓	✓	✓
Slice Move	✓		
Corner Rounding	✓		
Coordinate Transformations	✓	With Plug-In	
Kinematics	✓	With Plug-In	
Loop Transmission	✓	✓	✓
Advanced Diagnostics and Tuning	✓	✓	✓
Auto Focus	✓	✓	✓
MATLAB®	✓		
Force Control	✓	✓	✓
Soft Landing	✓	✓	✓
Piezo Nanopositioners	✓	✓	
HexGen Hexapod	✓		
RCP-DELTA Delta Robot	✓		

# 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.



# Aerotech Machine Safety Standards



Safety Level	Fault Detection	Loss of Safety Function Probability	Single Fault Covered	Double Fault Covered	Input ESTOP Signal	Supply Power to Drive
<b>Category B</b>	None	Very High	No	No	No specific design	No specific design
<b>Category 1</b>	None	Very High	No	No	Simple mushroom switch	One relay
<b>Category 2</b>	Low	High	No	No	Simple mushroom switch	One positive guided relay with auxiliary contact for checking
<b>Category 3</b>	Medium	Medium	Yes	No	Dual circuit mushroom with fault detection	Two positive guided relays with cross checking
<b>Category 4</b>	High	Low	Yes	Yes	Dual circuit mushroom with independent fault detection	Two positive guided relays with cross checking

# Hardware Options

	MP	CP	HPe	HLe	ML	Integrated Drive Racks		Nservo	Nstep	Nmark™	Console	QL/QLe
A3200 Drives												
Ensemble Controls								N/A	N/A	N/A	N/A	
Soloist Controls						N/A		N/A	N/A	N/A	N/A	N/A
Axes	1	1	1	1	1	1 to 8	1 to 8	2 or 4	2 or 4	3	1 to 12	
Output Type	PWM	PWM	PWM	Linear	Linear	PWM and Linear	PWM and Linear	Three-Phase ±10 V	Clock and Direction	Clock and Direction	N/A	
Peak Output Current	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	N/A	N/A	N/A	N/A	
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: 80VDC	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	N/A	N/A	N/A	N/A	
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	11-DI/8-DO 4-AI/2-AO	16 Assignable IO	N/A	N/A	
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	Via Optional Ethernet Port	N/A	N/A	N/A	
I/O Spec	12-bit differential AI 16-bit single-ended AO	16-bit differential AI 16-bit single-ended AO			Npaq or HEX RC: Four 16-bit differential AI Two 16-bit single-ended AO Npaq MR: Same as ML or MP per axis		Epaq or Epaq MR: Same as ML or MP per axis Ensemble QLAB: 4 AI, 4 AO Ensemble QDe: 1 16-bit, 1 18-bit	Two 16-bit differential AI Two 16-bit single-ended AO	N/A	N/A	N/A	
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



# Aerotech Drive Solutions

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

### Torque

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

### Torque

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

### Torque

**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

# Brushless Linear Servomotors — Flat and U-Channel

## Torque

**Type:** Frameless  
 Continuous Torque: 0.20 - 29.09 N-m  
**Peak Torque:** 0.82 - 116.37 N-m  
 Rated Speed: 200 - 8000 rpm

Five frameless designs for easy integration into OEM machines.

Slotless stator and high-pole-count rotor provide zero cogging for exceptional velocity control.

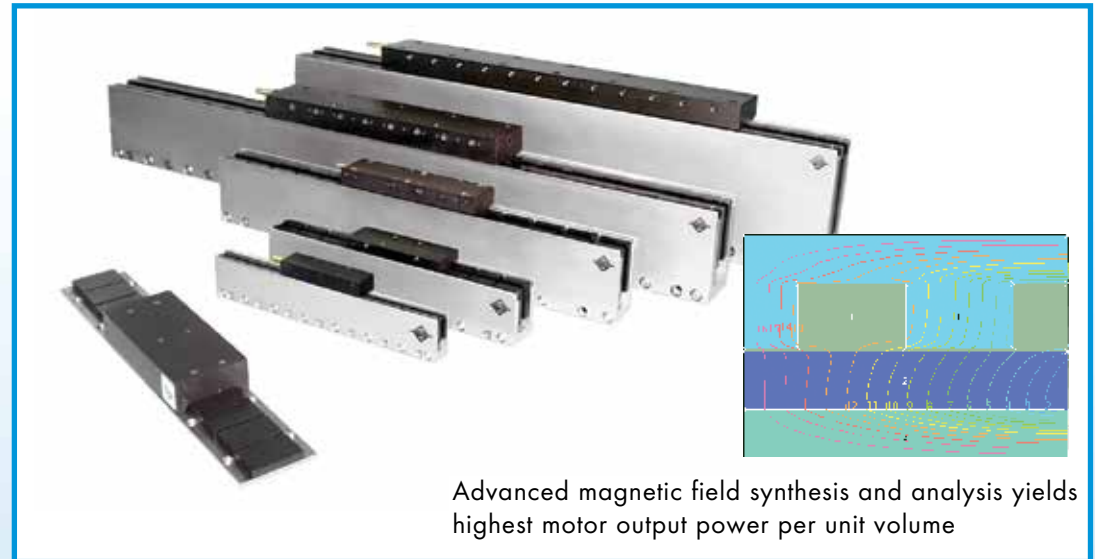


## Force

**Type:** Flat  
 Continuous Force: 19 - 697 N  
**Peak Force:** 75 - 1507 N

Aerotech's proprietary coil winding technology produces the highest force to volume ratios available.

Direct drive, noncontactingforcer coil eliminates backlash, windup and wear for a maintenance-free system.



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

## Force

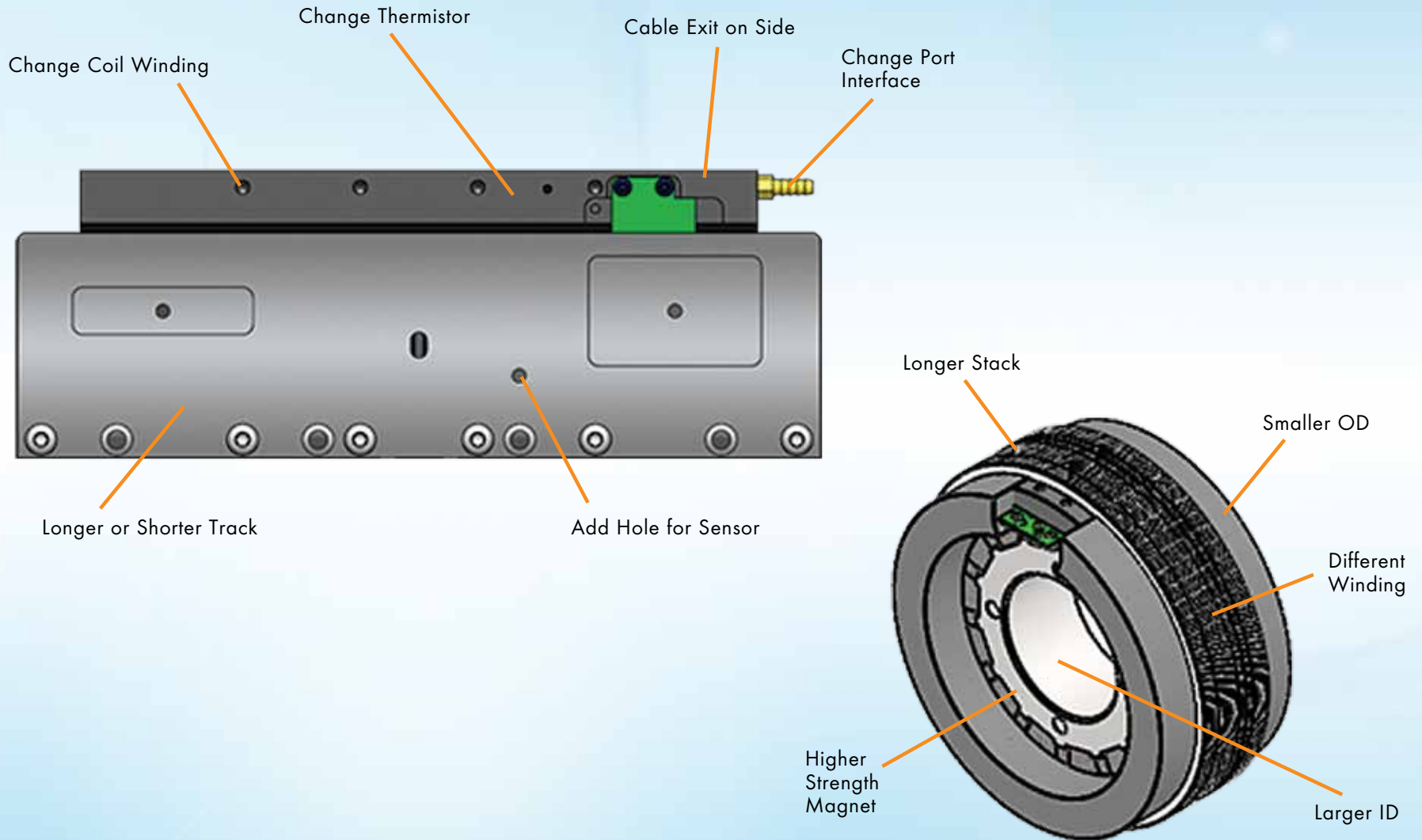
**Type:** U Channel  
 Continuous Force: 18.3 - 1063 N  
**Peak Force:** 125 - 4252 N

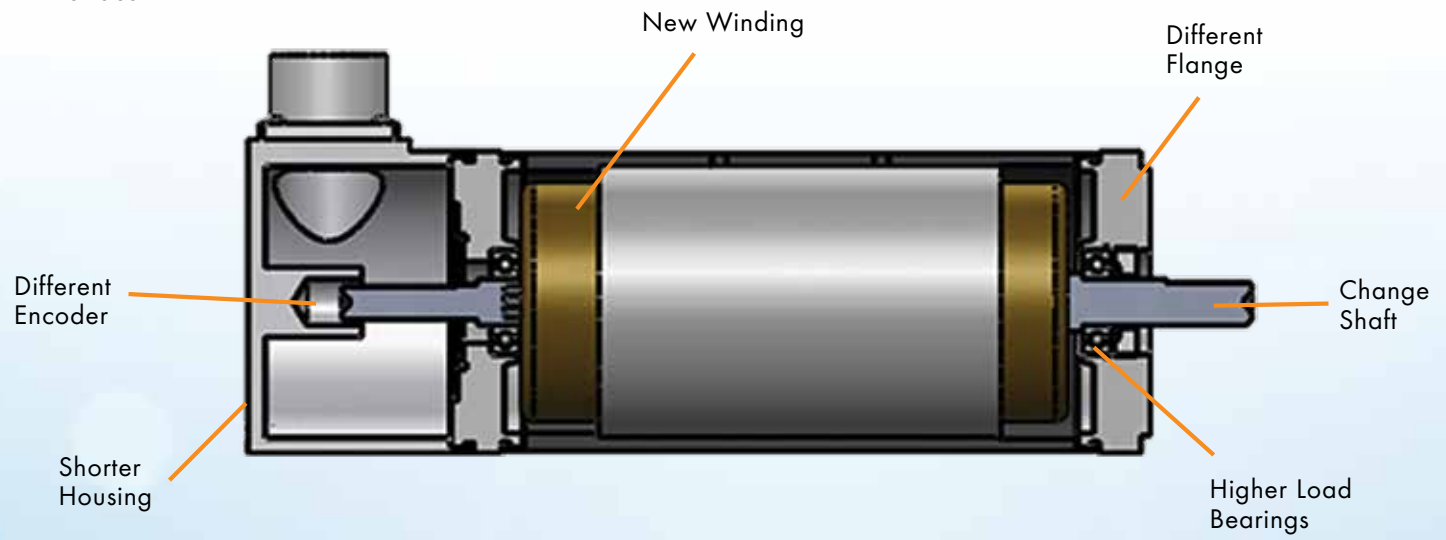
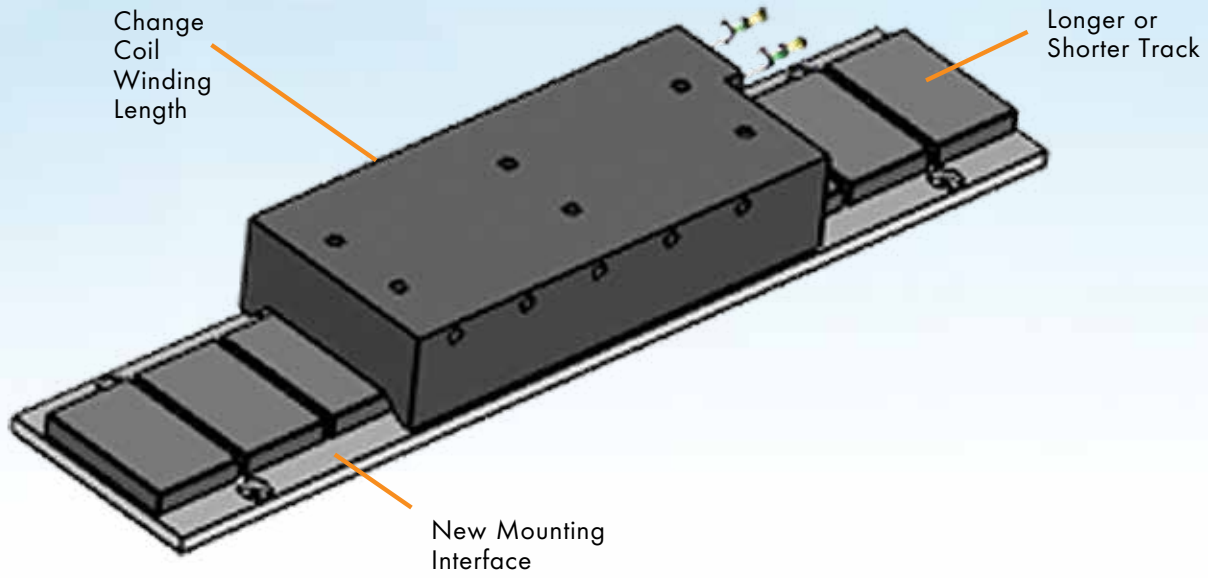
Linear servomotors are ideal for:

- Robotics
- Packaging
- Actuators
- Tables/Stages
- Assembly
- Fiber Optics/Photonics Alignment and Positioning
- Machine Tools
- Semiconductor Equipment
- Electronic Manufacturing

# Custom Motors

We customize for you





# Accessories

## Available Accessories:

Maple Operator Interface  
Joystick  
Handwheel/Pendant  
Transformers

Power Supplies  
Cables  
Automation Server  
MXH Multiplier Boxes

Line Filters  
Panel PC



# We customize for you...

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

## Connectivity

- Ethernet
- Fieldbus
- Wireless
- USB



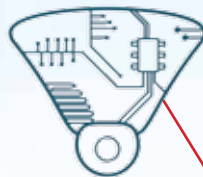
$$\frac{F(s)}{D(s)} = \frac{s^2 \prod (s^2 + \omega_{z_i}^2)}{A [s^2 \prod (s^2 + \omega_{p_i}^2) + \sum \frac{b_{k_1} s + b_{k_2}}{s^2 + \omega_{k_i}^2}] \prod (s^2 + \omega_{d_i}^2)}$$

## Custom Control Algorithms

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

## 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



## 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



## 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 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



# 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.



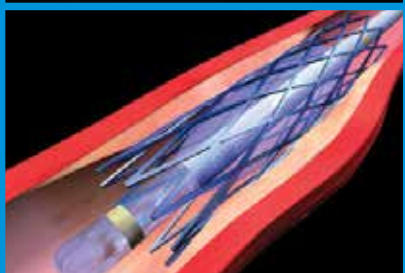
## Aerotech personnel will:

- 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
- Write PLC programs using Ladder, Function Block, or Structured Text
- Product customization
- Product application
- Write/configure HMIs
- Integration with process controller

## Benefits include:

- Maximize machine performance
- Minimize machine development time
- Minimize cost





**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**



# 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.

# 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

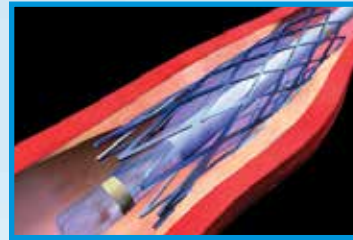
- Packaging Machines (Multi-Axis Applications)
- Web Applications
- Printing Applications
- Rollover Unit Testing
- IMU Testing
- ECM
- Marking
- Vertical Form, Fill, and Seal

## 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.



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.

### 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

## Packaging

Line following applications including:

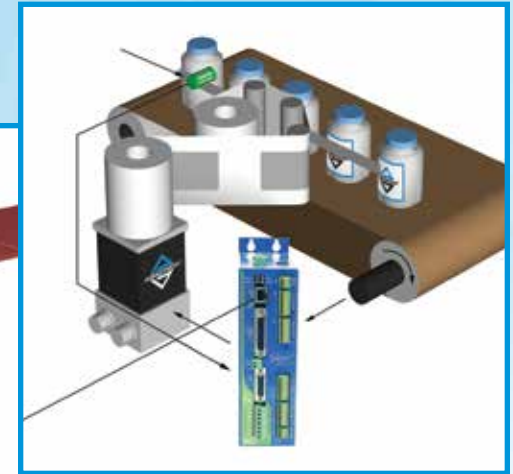
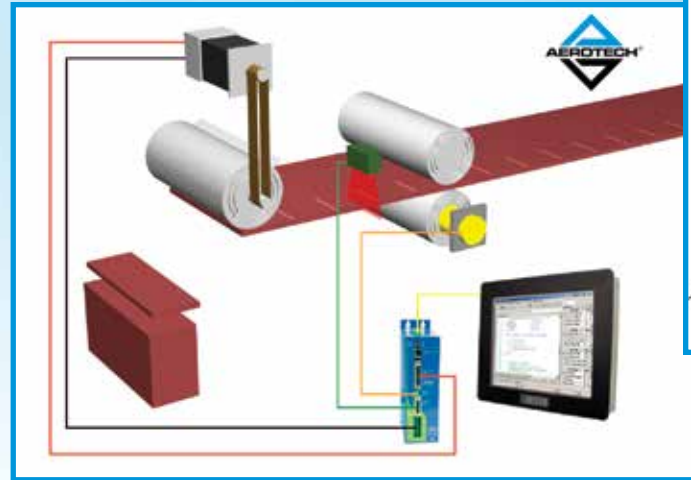
- Labeling, cut-to-length, fly cutting, lane diversion, rotary knife and many others.

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

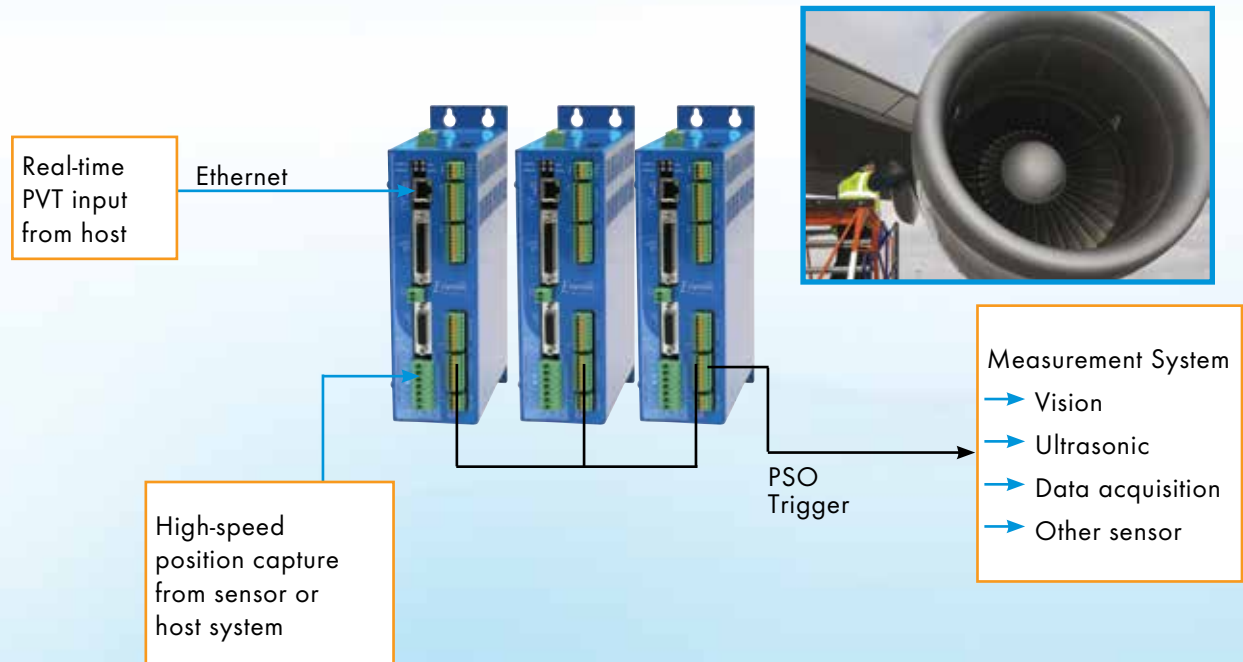


## High Accuracy, Multi-Axis Inspection Systems

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.

## PC-Based



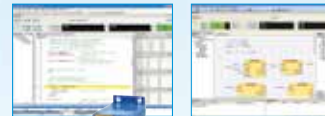
UNIDEX® 500



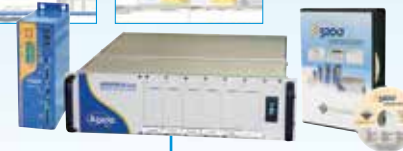
UNIDEX® 600



A3200



Integrated Automation  
PLC + Motion = MotionPAC



Delta  
Robot  
Control

2000



UNIDEX® 400



UNIDEX® 511



Soloist®

2010



Ensemble®

2016



Piezo Controls



Hexapod  
Control

## Stand-Alone

2000



UNIDEX® 100



BAI

# 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



Aerotech Inc (U.S.A.)



Aerotech Ltd (United Kingdom)



Aerotech GmbH (Germany)




Aerotech KK (Japan)

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



Corporate Headquarters • Pittsburgh, PA • USA



Aerotech UK



Aerotech Germany



Aerotech Japan



Aerotech China



Aerotech Taiwan



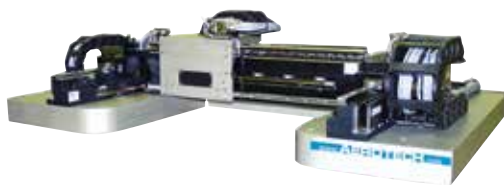
Aerotech Thailand

## High Performance Sub-Assemblies



XYAB subsystem for high dynamic accuracy positioning in laser drilling and micromachining applications

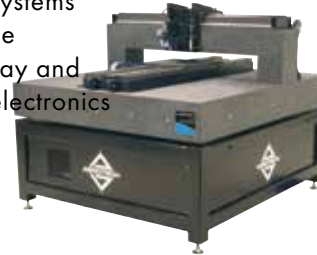
HexGen high-load, ultra-precision hexapod provides unmatched performance



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

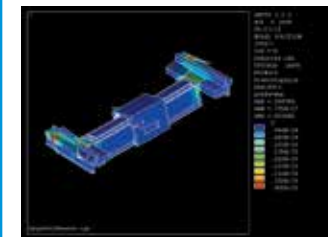
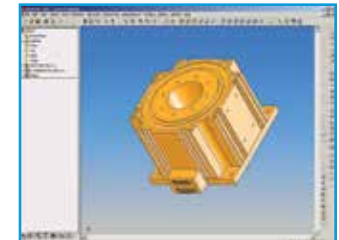


## Comprehensive Technical Support Services



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

[www.aerotech.com](http://www.aerotech.com)