Get Moving Faster

Part of the Automation1 precision motion control platform, the Software-Based Machine Controller (iSMC) tightly integrates precision motion with process control. Whether you're programming a simple move, building a complete machine, or doing something in between, the Automation1 iSMC delivers high-quality automation and improved throughput.

And the iSMC integrates with the Automation1 Motion Development Kit (MDK) — the most user-friendly interface available for precision motion control — to get you moving faster. You'll quickly configure and develop your application, easily set up control devices — drives, motors and stages — and enjoy programming with features like intelligent autocomplete, context sensitive help, EasyTune®, live build checking, a variable and I/O watch window and more.

Powerful Features for Automated Solutions

From the advanced AeroScript™ programming language and powerful Aerotech motion engine to multiple options for easily integrating complex automation solutions, you'll have everything you need to get your process in motion.

- *Runs on a real-time operating system (RTOS) installed on a Windows 10-based industrial PC*

- *Connects to motor drives, galvo scan head controllers and more over Aerotech's HyperWire® fiber-optic communication bus, which has 20x the bandwidth of 100BASE-T Ethernet buses*

- *Creates 20 kHz servo motor trajectories and 100 kHz galvo scan head trajectories*

- *Connects to and synchronizes motion trajectory and I/O for up to 32 drives*

- *Enables custom machine interfaces and control schemes that work side-by-side with application programming interfaces (APIs) from other vendors through the .NET API*

- *Executes real-time application code developed in the Automation1 Studio application*

- *Integrates with the Automation1 MDK, the most user-friendly interface available for precision motion control*

PRECISION MOTION COMES FIRST

Precision motion control is at the Automation1 iSMC's core. The iSMC runs on a real-time operating system and generates 20 kHz servo motor trajectory rates. With powerful lookahead technology, its Aerotech motion engine translates your programmed trajectory into multi-axis, synchronized commands sent to up to 32 axes over our new HyperWire® fiber-optic motion bus.

Additionally, the iSMC's proprietary C programming language interface enables kinematics to be calculated at the same rate as standard trajectories.

INTEGRATE YOUR PROCESS

The iSMC enables different approaches to incorporating vision systems, robotics, laser control, sensors and more.

Use the .NET API side-by-side with other APIs to build a complex control architecture and custom user interface, or build custom functionality by programming applications with the AeroScript programming language. AeroScript programs run on a RTOS, which allows code to execute faster and more deterministically than Windows-based applications.

Many users take a hybrid approach, using the API and AeroScript language to combine user interface design with high-performance, real-time application code.

REAL-TIME PROGRAMMING

Build custom functionality into your application with the AeroScript programming language. AeroScript's modern syntax is easily accessible when programming in the Automation1 Studio application's integrated development environment.

You'll use this advanced language to build structures, declare variables, perform mathematical operations, call functions, return values and so much more. Internal libraries include in-demand features like basic and advanced motion, transformations, I/O, controller status and data collection.

Better yet, AeroScript enables you to build your own libraries and then circulate only the compiled version — protecting your intellectual property.

BUILT FOR COLLABORATION

The complete Automation1 MDK, which includes status utility and console applications, can be installed on multiple workstations free of charge. This means your whole team can log in and collaborate on an Automation1 iSMC controller.

Expert-Level Motion Control

Known for precision motion control, the iSMC can command up to 32 axes of coordinated or independent motion and communicate to Automation1 servo motor drives over the HyperWire fiber-optic communication bus at a 20 kHz trajectory rate.

Both independent and coordinated moves feature:

- *Linear, rapid and arbitrary (point-by-point) single- and multi-axis move commands*
- *Advanced trajectory lookahead and acceleration limiting*
- *Linear, half-sine and s-curve acceleration profiles*
- *Trajectory transformations, including scaling translations, rotations and mirroring*
- *Velocity profiling mode*
- *Manual feedrate override (MFO) and feedrate hold*
- *Motion command completed verification (by position, velocity or minimal time)*

Acceleration Limiting

Coordinated Motion

$$\vec{V} = \vec{X} + \vec{Y}$$

Velocity Profiling
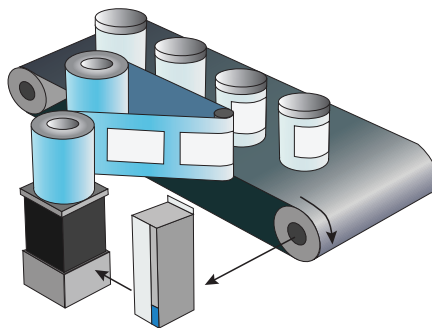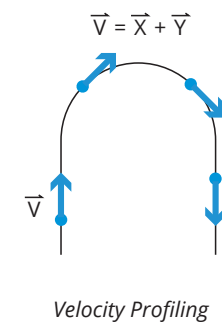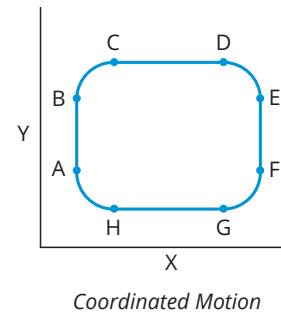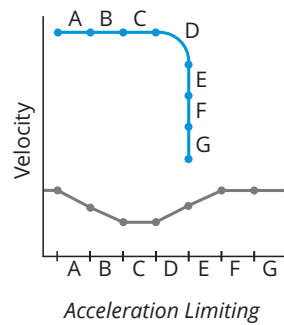
Electronic Gearing

Camming
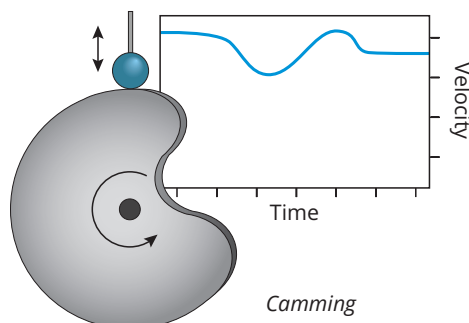
Precision Control for Each Axis

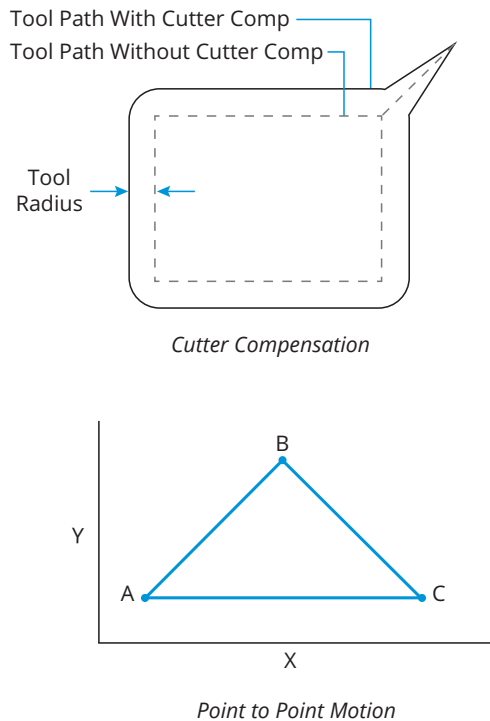The iSMC provides user-friendly, accessible functionality for each axis it controls.

Choose from seven homing functions; speed, distance and distance hold jogging controls; axis in position verification and axis stability verification; incremental motion; geared motion; camming motion and freerun motion commands.

Standard commands include moving an axis into and out of two opposing limit conditions.

Tool Path With Cutter Comp
Tool Path Without Cutter Comp

Tool
Radius

Cutter Compensation

Point to Point Motion

Multi-Axis Motion Control

Coordinate up to 32 axes to move in both multi-axis coordinated and non-coordinated methods. Coordinated moves start and stop simultaneously and can incorporate a velocity profiling mode of operation. Non-coordinated moves start at the same time, but do not necessarily end at the same time.

Set up multi-axis move commands to obey coordinated acceleration values and apply acceleration limiting via multi-axis trajectory lookahead. This acceleration limiting feature greatly improves following error along a contoured motion path.

Because it's often advantageous to control your process based on velocity or position, analog outputs can track vector velocity commands or feedback signals, while industrial lasers and other tools can be set to trigger based on distance traveled.

Multi-axis coordinated velocities and accelerations can also be limited by the use of a dependent axis — a particularly helpful feature if your machine has a rotary axis with known required limitations.

Calibration and Corrections

Use metrology tools to gather information about linear and angular errors, then build calibration tables to load onto the controller. Correction values from the tables are applied automatically and do not change the programmed positions presented in the user interface.

The controller natively supports 1D, 2D and orthogonality calibration tables. Cross-axis calibration methods — often used to correct the position of an axis based upon the position of one or more other axes — are also available. Multiple calibration tables can be used in combination.

Finally, backlash compensation corrects for the mechanical backlash in gear-driven and ball screw-driven mechanical systems.

1D axis calibration

2D axis calibration
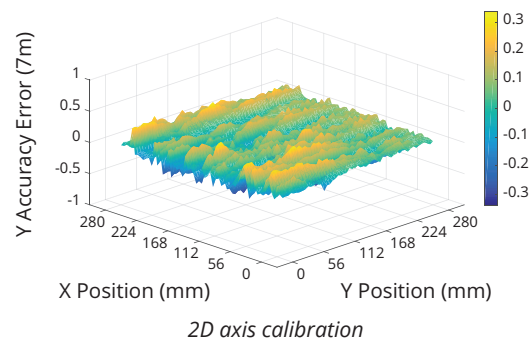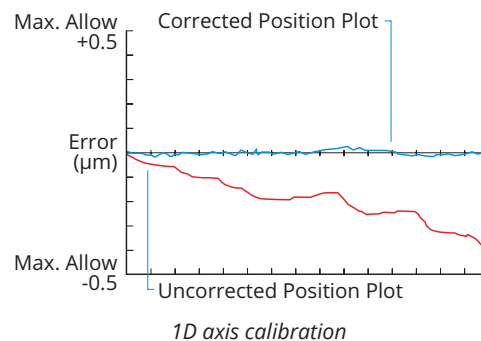
Complete Machine Control

The AeroScript programming language can program up to 31 controller tasks, enabling each task to better manage specific aspects of your machine's functionality. The features most often used for machine control include:

- *Fault and error handling*
- *The controller file system*
- *Message callbacks*

- *Signal logging*
- *Automation1 studio application customization*
- *Safe zones*
- *Cutter compensation*
- *Analog and digital I/O*

Protect your process by limiting access to the controller. Automation1's Access Control feature prevents unwanted users from connecting to an Automation1 controller.

See this Example of how you can use Task-Based Programming to deploy machine control

PROGRAM TYPE	HOW PROGRAM IS RUN	CONTROLLER TASK	TASK FUNCTIONALITY
Controller Task	Machine operator (or custom process) loads and runs program on the machine	1	Part and/or inspection routine motion
Program Automation Program	Loaded and run on specified controller task via Automation1's program automation feature	2	Machine-related motion
		3	Joystick/handwheel interface
		4	PLC functionality
		5	Data acquisition

Fast Position Capture

14.6 µm   12.678 µm
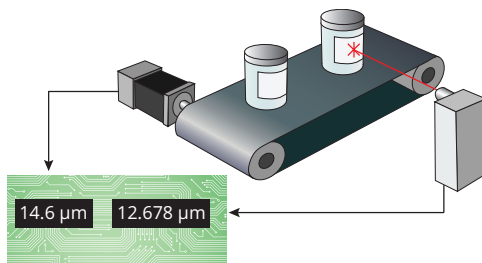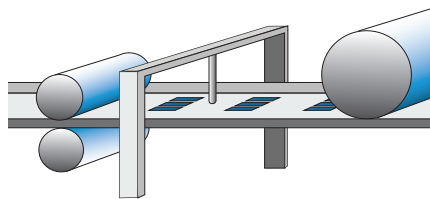
High-Speed Registration

Control Your Process Tool

With position synchronized output (PSO), you can control industrial lasers, cameras and other tools with less latency. Set analog outputs based on motion conditions, such as vector velocity. Complete processes such as on-the-fly end point modification, high-speed registration, constant force generation, spindle control and fast position captures. Electronic gearing and cam tables are both available, too.

The iSMC works in combination with memory on Automation1 drive electronics to control I/O and acquire data based on logic that operates at the drive. This means data can be captured and I/O can be set at rates as fast as the drive's own 20kHz servo control rate. This data is transferred to the controller and can be written to files for later evaluation.

Do More with AeroScript

With our new AeroScript programming language, you'll get more out of your iSMC than any previous controller. Although it's easy to learn and use, AeroScript provides the advanced features software engineers and developers need.

In addition to making your code more flexible and portable, AeroScript gives you the power to build libraries and distribute those files in their compiled version — providing intellectual property protection to your machines.

NATIVE AEROSCRIPT FEATURES	NATIVE AEROSCRIPT LIBRARIES	
Variable scope: global, program and local variables	Basic motion and motion setup	Pulse
Variable types: numeric, axis, string and handle	Advanced motion	Servo loop tuning
Variable arrays and array manipulation	Transformations	Signal logging
Integer and floating point literals	Analog and digital I/O	Fault and error handling
String operators	Controller status	Mathematical
Structures and enumerations	Data collection	String manipulation
Conditional and iterative execution	Task control	File and file system
Labels and unconditional branching	Program control	Position synchronized output
Functions and returns	Parameter control	Message callback
Use defined library with intellectual property protection	Galvo	
Message callbacks	Joystick	
Signal logging and data acquisition	Safe zones	
RS-274 G-Code	ThermoComp	
Operators: assignment, compound assignment, arithmetic, comparison and more	Brake	
	Encoder echo	

Easily Access Data

The iSMC gives you fast and easy access to data through the Automation1 studio application and libraries.

More than 100 axis status items, 50 task status items and 25 system-level status items are available to collect in the Automation1 studio application.

Each of these items can be displayed using the data visualizer, written to a file and exported to a Windows file.
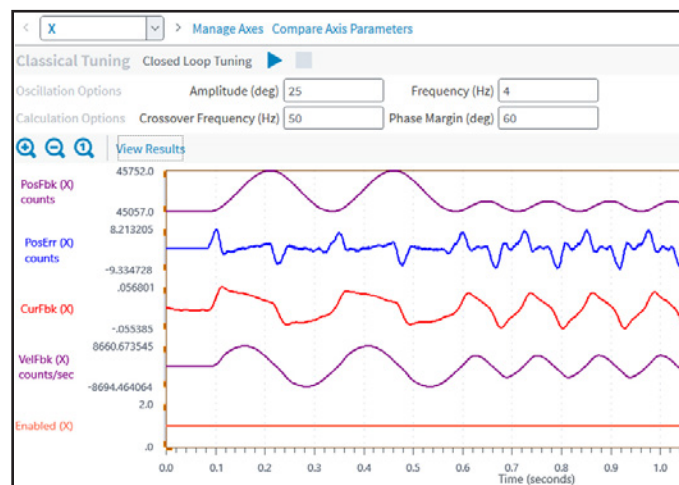
Gantry Control at Lightspeed

Get higher throughput, more precise gantry control via MIMO decoupling of gantry motion axes from their linear and yaw axes of control. Control gantries using any combination of Automation1 servo motor drives, as the lightspeed HyperWire motion bus connects even single-axis drives together without the need for complex and costly wiring.


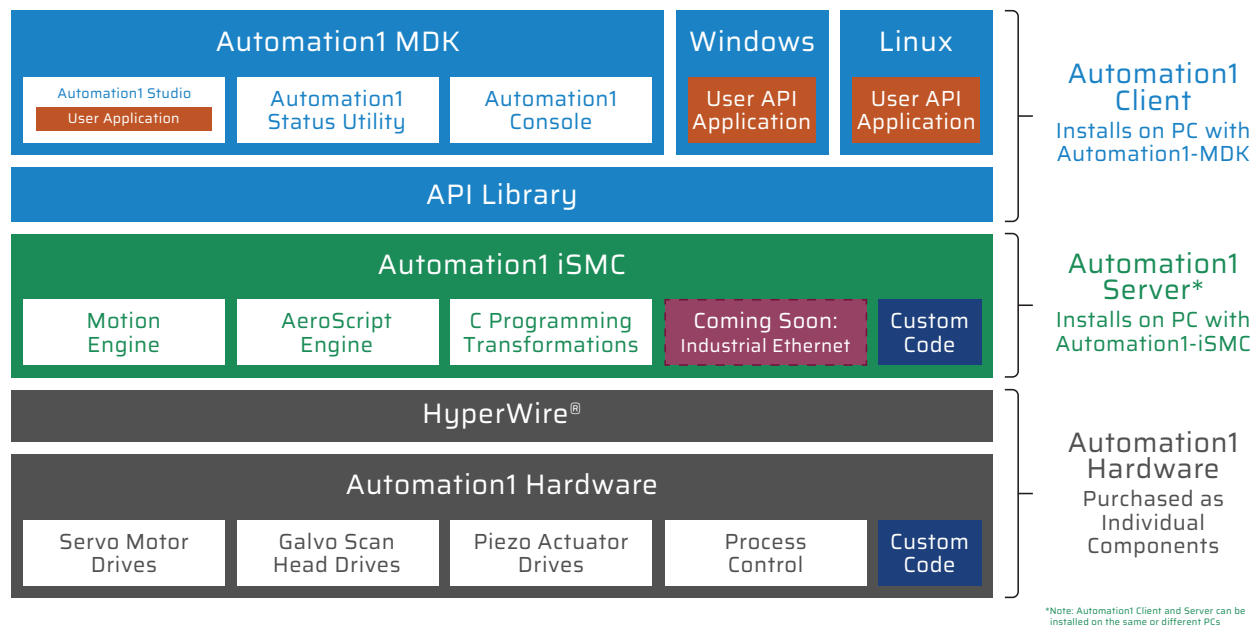## All the Flexibility of .NET Core

From programming simple motion to coordinating and synchronizing the motion of multiple axes in your machine, the iSMC provides the flexibility and power you need to tackle today's automation challenges — and it's all accessible through a powerful .NET API, built on .NET Core.

You'll never have to worry that using Aerotech's API will reduce the capabilities of your own products or developments. The powerful Automation1 .NET API is made accessible to our customers in the same structure and format that we use to develop our own applications.

Our APIs make it easier than ever to connect, configure, execute commands, program files, communicate, monitor status and collect data.
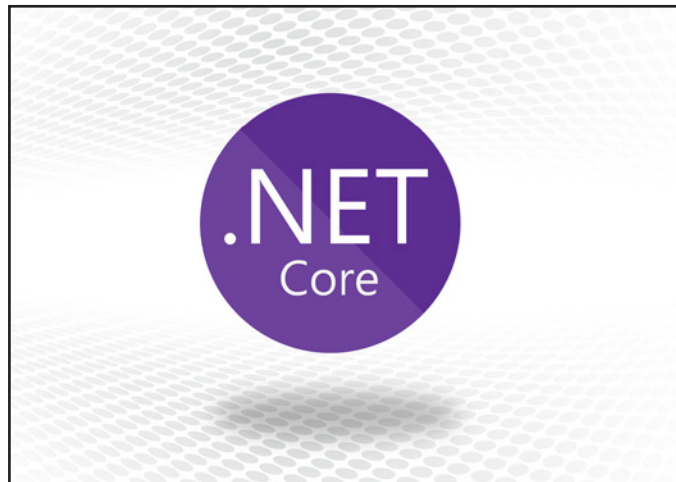
FUNCTIONALITY	DESCRIPTION
Connect	Connect to one or several controllers.
Configure	Configure settings, set/retrieve controller and drive parameters, tune motors and encoders, and load drive firmware.
Execute Commands	Execute AeroScript commands in .NET.
Program Files	Compile AeroScript programs, get build errors, load and run AeroScript programs on the controller, and handle the controller tasks that run AeroScript programs.
Communicate	Set up and command drive and controller communication ports and protocols.
Monitor Status	See status and monitor information coming from the controller.
Collect Data	Collect data on the controller in real time (this exposes functionality used by the data visualizer).

Automation1 MDK

Automation1 Studio
User Application

Automation1 Status Utility

Automation1 Console

Windows
User API Application

Linux
User API Application

API Library

Automation1 Client
Installs on PC with Automation1-MDK

Automation1 iSMC

Motion Engine

AeroScript Engine

C Programming Transformations

Coming Soon: Industrial Ethernet

Custom Code

Automation1 Server*
Installs on PC with Automation1-iSMC

HyperWire®

Automation1 Hardware

Servo Motor Drives

Galvo Scan Head Drives

Piezo Actuator Drives

Process Control

Custom Code

Automation1 Hardware
Purchased as Individual Components

*Note: Automation1 Client and Server can be installed on the same or different PCs

The Automation1 MDK installed on a client PC

The Automation1 studio application
The Automation1 status utility application
The Automation1 console application
The Automation1 .NET API DLLs and help (.NET API is built on .NET Core)
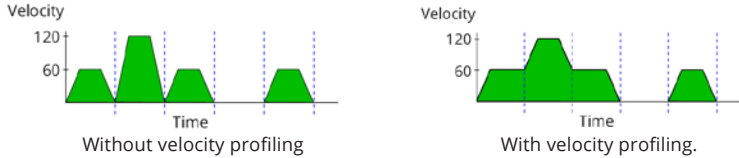The Automation1 general help files

The Automation1 iSMC installed on a server PC (client and server PC can be a single PC)

The Automation1 iSMC motion engine
The Automation1 iSMC AeroScript engine
The Automation1 iSMC C transformation interface (consult factory)
Industrial Ethernet support (coming soon)

The HyperWire® fiber-optic communication bus and Automation1 hardware devices, including

Servo motor drives
Galvo scan head drives
Piezo nanopositioner drives (coming soon)
Process control features on each drive
Custom controller and drive firmware code is available (consult factory)

SPECIFICATION	DESCRIPTION
Axes	32 axes available
Programming Tasks	31 user tasks available
Position Modes	Absolute, incremental, dynamic trajectory correction
RS-274 G-Code Support	Automation1 includes RS-274 standard G-code motion, including linear, circular, helical and spherical interpolation; cutter radius compensation; normalcy; parts rotation; mirroring; path retrace; polar transformations and cylindrical transformations; and scaling.
Coordinated Motion Types	**Coordinated Synchronous Motion** Coordinated motion refers to moves that follow a well-defined path in space. Coordinated moves start and stop axes at the same time. They can execute in velocity profiling mode. • Linear motion • Clockwise and counterclockwise
Independent Motion Types	**Non-Coordinated Synchronous Motion** Non-coordinated motion refers to moves in which axes start at the same time but do not necessarily end at the same time. Each axis moves at its own velocity specified in the command or by axis parameters. Program execution does not continue to the next line until all axes in the move command have completed motion. **Homing** Multiple procedures are available to establish the home position of an axis: • Home past limit switch to home marker • Home to limit switch and reverse to home marker • Home to home marker • Home to limit switch • Home at current position and set to zero • Home at current position and set to nonzero • Home at current position and set to absolute position **MoveRapid Command** Generates single or multi-axis point-to-point motion **Asynchronous Motion** Asynchronous motion commands cause program execution to continue on to the next program block immediately after the move starts. The controller does not wait for the move to end before continuing to the next command. • Home an axis without waiting for completion • Free run an axis at the specified velocity • Move to an absolute position • Move incrementally • Move an axis out of a limit condition • Move an axis into a limit condition • Move point by point (PVT, PT)* *PVT and PT motion normally blocks the task.

SPECIFICATION	DESCRIPTION
Acceleration Profiles	**Acceleration Types** • Linear-constant acceleration applied, resulting in linear velocity profile • Sine (sinusoidal half-sine)-parabolic acceleration applied, resulting in a sine wave velocity profile • S-curve-trapezoidal acceleration applied, resulting in an "s-curve" velocity profile **Acceleration Modes** • Time based - axis acceleration takes place over a specified time • Rate based - axis acceleration takes place at a specified rate
Velocity Profiling	Blend multiple, coordinated motion commands into one continuous motion path. In velocity profiling mode, the controller does not decelerate to zero between consecutive, coordinated moves. Velocity can be changed during the move sequence. The axes will increase or decrease in speed in a coordinated way to maintain the programming path. Without velocity profiling With velocity profiling.
Advanced Features	• Corner rounding • Orthogonality correction • Tool normalcy control • Electronic gearing • Cutter compensation • EasyTune® & classical tuning • Programmable fixture offsets • Backlash compensation • Part profile rotation • Spindle motion • Part profile scaling • High-speed registration • Polar & cylindrical transformations • Multi-dimensional error mapping
Access Control	Control who can connect to the Automation1 controller. Access Control utilizes Windows groups and users, including the active directory, to quickly deploy added security to your system.
Controller Files	The Automation1 Controller has a local file system. Part programs, program automation files, calibration files and more are stored locally on the controller and managed via the Studio application.
Safe Zones	**Safe zones prevent motion either into or out of n-dimensional hypercubes.** • Typical dimensions: 1, 2 or 3 • Maximum dimension: 32 • Maximum number of safe zones: 32 • Boundary action: When motion approaches the boundary of an area that is not permitted, the motion decelerates smoothly and stops one count before it reaches the boundary.
Programming	• AeroScript • RS-274 G-code • .NET

PC Requirements and Configuration

Aerotech supplies free support for Automation1 installation if you purchase an Automation1 iPC industrial PC or an approved PC from the supplier list that is maintained on the Automation1 iSMC website.

Automation1 iSMC Machine & Motion Control Developer's Kit

License (Required)

-L1	Automation1 iSMC installation on a single PC
-L2	Adds a paid option to an existing license* **
-L3	Extends the subscription period for an existing license*
-L4	Increases the number of seats for an existing license*
-L5	Provides hard copy media for an existing license*

 *Requires the current License ID.
**Price is based on the new options added. If a subscription extension is required, an -L3 must be processed first.

Controller Plus

-CP0	Base controller (four user tasks, one reserved task)
-CP1	Controller plus option (31 user tasks, one reserved task)

HyperWire® Axes

-H00	No HyperWire axes connectivity (virtual mode)
-H06	Connect up to six HyperWire axes (default)
-H16	Connect up to 16 HyperWire axes
-H32	Connect up to 32 HyperWire axes

Contoured Motion

-CM1	Up to four axes of contoured motion
-CM2	Five or more axes of contoured motion (export controlled)

Controller Subscription

-S1	One-year subscription to software version upgrades
-S3	Three-year subscription to software version upgrades
-S5	Five-year subscription to software version upgrades
-S0	One-month subscription to software version upgrades

HyperWire Card

-HW0	No HyperWire card
-HW1	HyperWire card included

Installation Media

-M1	Installation file downloaded from aerotech.com
-M2	Installation file provided on USB and downloadable from aerotech.com
-M3	Installation file provided on CD and downloadable from aerotech.com

Version

-Default	Current version of software
-Legacy	Legacy version of software

HyperWire Communication Network (Items Ordered Separately)

Automation1 Communication Accessories (ComAcc)

HyperWire® PCIe	HyperWire interface card, PCIe bus.

Aerotech Communication Cables

HyperWire AO10-5	HyperWire cable, AOC, 10G, 5DM
HyperWire AO10-10	HyperWire cable, AOC, 10G, 10DM
HyperWire AO10-30	HyperWire cable, AOC, 10G, 30DM
HyperWire AO10-50	HyperWire cable, AOC, 10G, 50DM
HyperWire AO10-200	HyperWire cable, AOC, 10G, 200DM