



Motion Control The SLC Way



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Bringing Together Leading Brands in Industrial Automation

Motion Control Made Easy

Pick the Right Tools for the Job

Every good craftsman knows you need the right tools to get the job done **right**. And motion control applications are no different. You want a Motion Control System that will fit *your* needs. If you're doing basic motion control, the best tools for a cost-effective Motion Control System can be the Allen-Bradley SLC 500™ Motion Control Modules. If you've got more complex motion control challenges, an integrated drive/controller combination like the 1394 GMC Turbo might be the best choice for your application. From basic to advanced, rack-based or connected via the SLC backplane, Rockwell Automation offers you the best tools for the job with the SLC 500 family of controllers, I/O and motion control options.

Simplicity in Motion Control

The SLC 500 Motion Control Modules are well suited to basic motion control and offer a wide variety of control solutions. Whether you're doing hydraulic or positioning applications, single-axis stepper or servo control, or high-speed registration, there is an Allen-Bradley SLC 500 Motion Control Module to meet your needs:

- **Stepper Control Module** — intended for single-axis, open-loop micro-stepping applications.
- **Servo Control Module** — engineered for single-axis servo control applications including packaging, labeling, conveyors, small assembly machines, and rotary tables.
- **High-Speed Counter Module** — perfect for high-speed or process motion control applications, such as material handling, flow monitoring, motor speed control, and machining.



- **Velocity Control Module** — an ideal solution for the control of simple one-axis hydraulic presses, die-casting machinery, weld-head positioning, and pneumatic actuators for placement and clamping where positioning and speed are not critical requirements.
- **Synchronized Axis Control Module** — designed for positioning applications where multiple axes must accelerate together and decelerate into position at the same time, such as plywood presses, roll positioning, palletizers and stackers, and forging machines.



And like all SLC 500 modules, each of the Motion Control Modules slide into the SLC 500 chassis for quick installation and replacement. The processor sends commands and receives module status

over the backplane every scan using its ladder programming. These modules include the intelligence needed to provide the user simplicity in motion control.

For More Advanced Applications

Rockwell Automation offers a high-performance, multi-axis servo system that covers a wide range of applications with an even wider array of features, including camming and gearing.

- **The Allen-Bradley 1394 GMC Turbo**

Digital AC Multi-Axis Motion Control System — ideal for a broad spectrum of motion control applications — from high-speed packaging and assembly, palletizing, and feed-to-length, to automated processes in industries such as food processing, pharmaceuticals, automotive, tire and paper manufacturing, and metals.

The 1394 GMC Turbo, with its innovative integration of drive and multi-axis motion functions, is a major advance in motion control efficiency and simplicity. It offers direct connection to the SLC 5/03™, 5/04™, and 5/05™ backplane. This high-speed direct connection allows the 1394 drive to benefit from the SLC's powerful processing and I/O functionality.

The Complete Solution

These modules are only part of the equation. The SLC 500 family features eleven CPUs and more than 60 discrete, analog, and specialty I/O modules to complete your motion control solution.

Finally, communication between the other components in your solution — drives and motors, encoders, sensors, and operator interface — can be easily done via a host of communication options:

- Ethernet®
- DeviceNet™
- DH-485
- RS-232
- ControlNet™
- Data Highway Plus™
- Remote I/O
- DF-1

If you need motion control that's cost-effective, modular and easily implemented, consider the options that the SLC 500 family offers. Whether you need the SLC 500 Motion Control Modules or the advanced functionality of the 1394 GMC Turbo, we'll help you build a system that's just what your application requires.



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Motion Control Will Never Be The Same

So many modules, so many configurations — never before has there been such flexibility in building a customized motion control system. With the SLC 500 family of processors and I/O, the Motion Control Modules and the 1394 GMC Turbo, we offer a complete portfolio of motion control choices that are both easy and cost-effective to implement.

As you evaluate which SLC 500 Motion Control options will best suit your application, refer to the detailed information on the following pages. Here you will find data concerning the specific functionality of each module, how the modules are configured, and how to integrate the modules into your current or new motion control system.

Aid For Electro-Mechanical Applications

1746-HSTP1 Stepper Control Module

The 1746-HSTP1 Stepper Module is a single-axis stepper controller. Operating with a variety of SLC 500 series processors, this single slot module is capable of providing up to 250 KHz pulse train output for micro-stepping applications.

Use this module for open-loop stepper applications with single-axis control requirements. The SLC processor's data table contains all the program and configuration information. The module also has the ability to interface directly with a quadrature encoder to monitor position. The five LEDs on the front of the module allow you to quickly determine module status and error conditions. Red signals configuration or programming errors, and green signals normal operation of the module.

The module is programmed and commissioned using RSLogix 500™, AI 500, or APS SLC programming software. For a given move profile, you program the distance, acceleration, deceleration, and velocity. With +5 or +15V encoders that provide differential feedback, the module interfaces directly to accept position information. Some additional features of the 1746-HSTP1 include:

- Single slot module
- Installation and programming ease, with no switches to set
- LEDs for status and error indication
- Built-in loop back diagnostics
- Independent acceleration and deceleration values



1746-HSRV Servo Control Module

The 1746-HSRV Servo Module is a single-axis, closed-loop servo controller. The single slot module can be operated in a variety of SLC 500 series processors with block execution independent of the scan time of the processor. The system is programmed and commissioned using RSLogix 500, AI 500, or APS software, and the ladder logic controls all of the motion. For fast accurate control, the module monitors encoder feedback up to 300 KHz.

Complicated moves are accomplished using blended motion profiles stored in the SLC Servo Control Module's internal memory and can be executed repeatedly. The profiles are stored as a series of absolute moves, and additional moves or homing operations can be performed between blended moves. The 1746-HSRV can automatically reset the absolute position to home position when an encoder marker pulse is detected.



With a capability of controlling absolute position over a range of 32 bits, coupled with the power of the SLC 500 processor, you get an economical solution for your motion application. More 1746-HSRV features include:

- Analog velocity command with programmable limits to interface with servo drives
- Three (3) fast inputs, and one (1) fast output
- 32 bit range for absolute positioning and blended motion profiles for complex moves
- Interfaces directly with +5 or +15V encoders

1746-HSCE2 Multi-Channel High-Speed Counter Module

The 1746-HSCE2 is a 24-bit high-speed, multi-channel counter that directly interfaces with incremental encoders and other high-speed input sensors. The module accepts bi-directional input pulse frequencies of up to 1 MHz. For faster throughput time, the module has four on-board outputs that are controlled independently of the output scan. The status of four "soft" outputs can also be made available to the SLC backplane for control of additional outputs.

The module supports three operating modes that provide two, three, or four-channel operation. It is configurable for two-channel quadrature/differential inputs, or four-channel single ended inputs. System performance is enhanced with the module's ability to accept control adjustments while it is actively counting pulses. In addition to monitoring an encoder marker pulse, the Z/gate input channel can be used for storing, holding, and resetting count data.

You save processor memory and scan time because the module provides transparent background rate calculations. With x2 and x4 counting modes, the 1746-HSCE2 can fully utilize the capabilities of high-resolution quadrature encoders. Additional features:

- Supports two counter types: Ring and Linear
- Supports Pulse and Direction, Up/Down Pulse, and Quadrature inputs
- Compatible with 5/12/24V DC input signals
- Compatible with all SLC 500 processors

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Help For Hydraulic Applications

SLC 1746-QV Velocity Module

The 1746-QV is an open-loop velocity control module offering alternative ways to move a hydraulic cylinder where pressure and/or speed are not critical to the specific application requirements. Using extend and retract profiles to change the voltage sent to the valve amplifier or pump motor drive, the module accelerates and decelerates the rod of the hydraulic cylinder for simple placement applications. The user's ladder programming within the SLC may be used to change both the position setpoint and voltage output, permitting active changes between each cycle. The voltage sent by the module to the proportional valves or pump motor speed regulates the ram speed. Force does not depend on the SLC scan, making it repeatable in its operation.

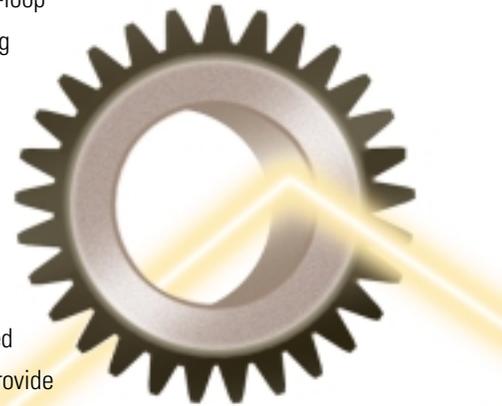
For applications with proportional valves, a linear displacement transducer (LDT) sends position information to the 1746-QV module. It can use as many as seven segments of extend and retract profiles configured for specific output voltages. These voltages drive a proportional amplifier connected to the proportional valve, which regulates the flow of hydraulic fluid into a hydraulic cylinder or motor. As an alternative, the output signal can be connected to an AC drive controlling the pump motor speed, thereby regulating the ram speed and force. Both setpoints and voltage outputs can be changed on-line by loading new profiles from the SLC controller to the 1746-QV module.

Even the newest and best mechanical components cannot endure extreme pressure spikes and constant water-hammering cycle after cycle. Now with the powerful combination of the SLC 500 and the open-loop velocity control module, you can implement a new or retrofit machine control strategy to keep your hydraulic system leak free. You'll also achieve repeatable operation through the addition of proportional valves and absolute positions from LDTs.

SLC 1746-QS Synchronized Axes Module

Providing four axes of closed-loop synchronized servo-positioning control, the 1746-QS allows on-the-fly changes to end-point, acceleration, speed, and deceleration while the axis is moving. Signals from linear displacement transducers directly connected to the module's four inputs provide 0.002 inch resolution over 200 inches. The module has four optically isolated outputs to interface with proportional or servo valve amplifiers.

Many hydraulic applications require two or more axes to reach their final position at the same time, such as plywood presses, hydraulic tailgate loaders, forging machines, palletizers, and stackers. The 1746-QS module was designed to work with the SLC processor to smoothly and accurately synchronize the axes. It can support independent axes, as well. This module's algorithm also supports servo or proportional amplifiers requiring a positive voltage irrespective of direction, but must interlock the operation using ladder programming.



Hydraulic Configurator Software

Configuring the synchronized axes module and tuning its axes are two tasks made easy with Hydraulic Configurator. The user may set up and tune each axis without the need for any ladder programming resident within the processor. Subsequently, the user creates ladder logic sequences using RSLogix 500 to handle the motion commands and axis status. Using standard M-file transfers, the user creates a library of configurations, then copies them to the module for accurate changeover between parts.

The quick and easy interaction with Hydraulic Configurator helps you obtain smoother operation and longer machine life. It limits pressure spikes to the hydraulic actuator by visually displaying its operation. The Configurator displays position and speed of the hydraulic actuator at intervals as fast as 2 milliseconds. The user interprets the resultant motion profile and adjusts tuning parameters such as proportional gain, velocity feedforward, and deadband to achieve the desired motion profile.

The 1746-QS synchronized axes module provides you with precise positioning, even at speeds greater than 120 inches per second. This module's algorithm has been specifically designed for the requirements of hydraulic actuators and proportional valves. The algorithm supports independent tuning parameters for the extend and retract direction when appropriate, active null drive adjustments, and deadband elimination.

If Your Application Demands More

The 1394 GMC Turbo

The unique integrated design of the 1394 GMC Turbo offers multi-axis motion control that is highly cost-effective, as well as simple to install, program, and operate. The motion control, positioning, and AC servo drive functions are integrated into this compact, full-featured, digital module. With standard I/O and M-file interfacing, you have an SLC backplane connection that supports two 1394 drops per SLC 500 rack for up to 8 axes of control. The 1394 provides up to four axes of control and you can synchronize up to 64 axes via AxisLink. The 1394 connects to the SLC via RIO, DH-485, or directly to the SLC backplane. Advanced features such as electronic camming, multi-axis interpolation and advanced gearing allow the GMC Turbo to provide field-configurable one to four axes of high performance closed-loop positioning and control.

Fast Installation and Setup

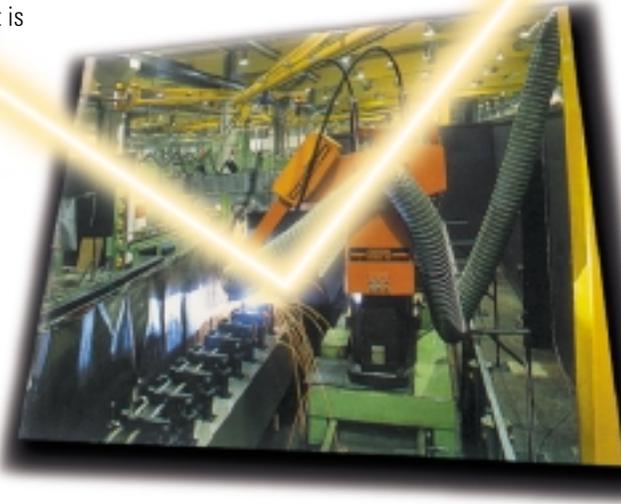
Slide-and-lock connectors, snap-on axis modules, and cable connection to the SLC eliminate complex and time-consuming installation and wiring. Axis module docking connections eliminate

the need for inter-module wiring. This slide-and-lock design provides all control and power connections without bus bars and wiring harnesses. Front-edge connections for motor power are the only wiring required. The exclusive Allen-Bradley GML™ (Graphical Motion Language) software makes programming the GMC Turbo quick and easy. Simply create a diagram of your application using graphical icons, and then fill in the motion and process details. Direct interrupt support between the 1394 GMC Turbo and the SLC 500 allows high speed event processing.

The Best for High-Speed Applications

The system module is a 32-bit, 25 MHz, 1960KB RISC processor that was designed to handle demanding, high-speed applications. Integrated Power Modules (IPMs) and IGBT (Integrated Gate Bipolar Transistor) circuitry provide smooth performance, quiet

operation, and greater reliability. The GMC Turbo power structure provides extremely high performance output. Synchronous current loops and a high band-width current loop (750 – 1000 Hz) ensure maximum utilization of this high voltage (560 – 680V DC) link. To extend operation during overload condi-



tions, adaptive IT control loops adjust operating characteristics. Advanced thermal modeling ensures that all critical devices operate within prescribed limits.

True drive/motion integration, an SLC backplane connection, lower cost over multiple axes, and greater reliability are all features that make the 1394 GMC Turbo the right solution for your high-speed motion applications.

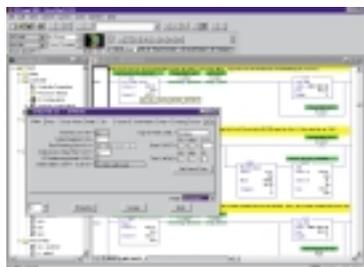
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Software Solutions

Want To Know More?

RSLogix 500 for Ladder Programming

RSLogix 500 offers flexibility, reliability, and increased productivity for ladder logic programming. It incorporates all of the latest



technologies to help you maximize performance, save project development time and dollars, and improve functionality. Enter instructions with click, drag, and drop

simplicity. A powerful ASCII editor gives you the ability to enter rungs quickly by entering the instruction mnemonics and parameters. Additional features include I/O Configurator, Symbol Group Editor, Symbol Picker, Rung Description, and Project Verifier.

GML Commander for Motion Programming

GML, or Graphical Motion Language, is the software used to program the 1394 GMC Turbo. It allows you to easily create a motion program by drawing a diagram using icons. Once the diagram is complete, you simply fill in the motion and process details. GML Commander is a 32-bit version which allows you to utilize the power of Windows 95® or Windows NT®. Set up dual trace windows for simultaneous views of modules, use a module navigator, perform data capturing or graphing, and monitor variables. The on-line manager allows direct communication with the controller.

Product	Publication Type	Publication Number
SLC 500	System Overview	1747-S0001B-US-P
1746-HSTP1	Product Profile Product Data	1746-1.6 1746-2.39
1746-HSRV	Product Profile Product Data	1746-1.8 1746-2.40
1746-HSCE2	Product Profile	1746-1.20
1746-QV	Product Profile	1746-1.10
1746-QS	Product Profile	1746-1.15
1394 GMC Turbo	Product Profile	1394-1.0
RSLogix 500	Product Profile	9398-LOGIXPF
GML Commander	Product Profile	GML-1.0

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