Thank you for your interest in Compumotor and our Acroloop family of motion control products. We are proud to offer you innovative solutions, unrivalled support and Selectable Levels of Integration™, which allows you the flexibility to create the system that is right for you.

Innovative Solutions

At Compumotor, our number-one goal is to ensure that your motion control application is solved successfully. We do this by offering a complete system solution utilizing innovative products and backing it up with premier customer service.

Unrivalled Support

Doing business with Compumotor means that you have access to the best technical support in the industry, including toll-free application assistance and highly trained local distribution.

Selectable Levels of Integration™

We manufacture all parts of a motion system, so we know what it takes to make it all work together. Whether you choose a single component, a motion system, or combine multiple Parker Automation products to provide you with a complete automation solution, Compumotor and Parker Automation provide exactly what you need and make sure your application is solved successfully.

With Compumotor, you have all the tools to ensure application success. ***Now you're in control!***

Contents

Support and Service

Parker World-Class Customer Service: Built on a Solid Infrastructure of Trained Experts in a Variety of Locations to Support You.

Local Support

Factory Authorized Automation Technology Center

At Parker, we understand the demands of the global marketplace. Throughout North America, Europe and the Pacific Rim, our motion control products are delivered and supported through a comprehensive network of Automation Technology Centers (ATCs). In addition to those services offered by traditional distributors, these organizations specialize in the application of high- technology automation equipment. ATCs offer local product availability, product demonstrations, programming assistance, system integration, local customer training and complementary products and services.

Your local independent ATC has been factory-trained to offer you expert service and advice. Parker Hannifin works cooperatively with its authorized ATCs to recruit, hire and train degreed engineers for positions with ATC organizations. More than 500 degreed engineers have been placed in our ATC organizations, each a graduate from an extensive factory training curriculum.

Parker's Electromechnical Territory Managers

Parker employs a skilled and motivated team of degreed, factory-trained field application engineers that represents all the divisions and products to make up a complete electromechanical system. Electromechanical Territory Managers (ETMs) work in conjunction with local ATCs and are ready to offer you assistance and provide direct factory contact.

Applications Support

Speak with a Motion Control Expert: Toll-Free Applications Engineering Assistance

When you have urgent questions, expert answers are only a phone call away. Our team of experienced engineers is ready to take your call from 7:00 AM to 4:00 PM PST. These engineers have practical field experience and are prepared to provide you with the application and product assistance throughout the stages of your project and for the life of the product.

Just call 1-800-358-9070. Outside the U.S., call 707-584-7558. Our staffing and support tools allow us to resolve most issues in less than one hour.

Internet

Get your Answers over the Internet

In addition to the toll-free number, you can contact Compumotor's Applications Engineering Department via the Internet. Via email, you can ask detailed questions, request literature, or send and retrieve files in a question-and-answer forum. Direct your email inquiries to *CMR_help@parker.com.*

Compumotor's Web site (compumotor.com) contains the most up-to-date information on Compumotor products and services. In addition, you will find:

- Catalogs online
- Product user guides
- DXF files
- Links to other Parker divisions and related sites
- Free downloadable software
- Application success stories.

Engineering Support Tools to Make Your Job Easier

Years of experience have culminated in a vast assortment of engineering support tools that help to simplify the sizing, selection, installation and troubleshooting process. There are also tools to help design a system to custom application requirements. A few of these tools include:

- Comprehensive engineering reference, available on CD-ROM or the Web
- Motor sizing and selection software
- Application programming software
- Product installation videos.

Compumotor is a division of Parker Hannifin Corporation . . .

. . . the global leader for components and systems designed to control motion, flow and pressure in all types of machinery and equipment. Parker offers more than 1,400 product lines that are utilized in more than 1,000 industrial and aerospace markets, providing its customers with a choice of hydraulic, pneumatic, electromechanical and computer-controlled motion systems.

Visit our Web site

Complete technical assistance and additional product information can be found on our Web site at compumotor.com. This site is continually updated to provide the latest information on current products, new product introductions, literature and support.

- Complete Product Catalog
- Product Selection/Configuration Wizards
- Free Downloadable Software
- FAQ Database
- Application Examples
- Engineering Reference Guide

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The ACR Family of Controls

Since the acquisition of Acroloop Motion Control Systems in 2002, the ACR family has been the highest performance motion controls in the Parker offering. Each of the five versions of the product is based on a 32-bit floating-point DSP producing unparalleled performance in the area of advanced multi-axis trajectory generation. Because the products are built upon a scalable platform, the same software set works on each of the controllers, providing easy upgrades and transfer of established application code between machines and applications. The hardware is also extremely flexible, allowing the design engineer to easily create the perfect controller configuration for his machine. The power of the ACR hardware is matched by an equally impressive array of software features allowing the design engineer the ability to solve any motion application.

Features:

- Backlash and ballscrew compensation
- Hardware and capture registers
- S-curve profiling
- String handling
- Time-based moves
- Synchronized master moves
- Segmented cams
- High-speed triggered cams
- Dual-feedback control (velocity and position)
- Analog or digital feedback
- Stepper or servo outputs
- Onboard diagnostics
- Onboard oscilloscope
- Software limits
- Torque limits
- Spline moves
- NURBS
- 3-D arcs
- Sinusoidal commutation
- Automatic tangential tool orientation

Controller Selection

	ACR8020	ACR8010	ACR2000	ACR1500	ACR1200
Motion Control					
32-bit floating-point DSP	YES	YES	YES	YES	YES
CPU speed	120 MFLOPS	60 MFLOPS	50 MFLOPS	40 MFLOPS	40 MFLOPS
Axes/controller	2-8 (expandable)	2-8	2-4	2-4	1-2
Servos	YES	YES	YES	YES	YES
Steppers	YES	YES	YES	YES	YES
Line/arc/splines/NURBS, 3D arc interpolation	YES	YES	YES	YES (except NURBS)	YES
Memory size STD (OPT)	512 K (2 MB)	512 K (2 MB)	512 K	128 K	128 K (512 K)
Flash for saving programs	512 KB (expan 2 MB)				
Pre-emptive multitasker	YES	YES	YES	YES	YES
Communications					
Interface	Binary, ASCII	Binary, ASCII	Binary, ASCII	Binary, ASCII	Binary, ASCII
COM1, COM2 serial	YES, optional	YES, optional	YES, optional	NO	YES, standard
Standalone option	N/A	YES	YES	NO	YES
PC-bus pluggable	YES, PCI	YES, ISA	YES, ISA	YES, ISA	N/A
Parallel (LPT) option	YES	YES	YES	NO	YES
Dual-port memory option	YES, standard	YES, optional	NO	NO	N/A
Bus mastering	YES	NO	NO	NO	N/A
Inputs/Outputs					
Encoder input	4-10 (expandable)	4-10	2-4	2-4	3
Encoder fault detection	YES, in hardware	YES, in hardware	NO	NO	YES, in hardware
D/A options	2-8 (expandable)	2-8	2-4	2-4	2
Uncommitted I/O	64 (exp. to 320)	64 (exp. to 320)	32 (exp. to 288)	48	32 (exp. to 160)
I/O type	24V Opto isolated	24V Opto isolated	24V Opto isolated	TTL	24V Opto isolated
I/O active hi/lo select	YES	YES	YES	YES	YES
AUX analog inputs 8 single Ended/4 differential	12 or 16 bits	12 or 16 bits	12 bits	12 or 16 bits	12 or 16 bits

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Real-Time Motion Control

With Floating-Point DSP

Ensuring the highest possible performance, ACR controllers use high-speed Digital Signal Processors (DSPs) from Texas Instruments for real-time calculations and motion control. TI DSPs feature:

- 40-120 MFLOPS
- Floating-point calculations
- Superior speed and accuracy (over fixed-point).

The ACR's processor-based controllers can quickly process floating-point calculations on-board, typically in the 100-500 usec range (products using software calculations are typically in the 5000-8000 usec range). This frees the controller to service a pre-emptive multi-tasker, with up to 24 programs at once, and service up to four communication channels concurrently. Thus, means you can communicate with an ACR controller for troubleshooting and still have the HMI on a production machine fully online and active!

Pre-Emptive Multi-Tasker

ACR controllers are true pre-emptive multi-taskers capable of performing multiple tasks simultaneously and toggling tasks based on the condition of a bit. A pre-emptive multi-tasker is the best choice when you have a program that need not always run, but needs to be available to run. For example, if you need to dress a wheel on a grinder based on an input or parametric equation, it would be a waste of time to have this program being serviced constantly. Without a pre-emptive multi-tasker, it would be necessary to allocate time for this little-used program. In a pre-emptive situation, the program would be dormant until called for, and only then would it require time to be serviced.

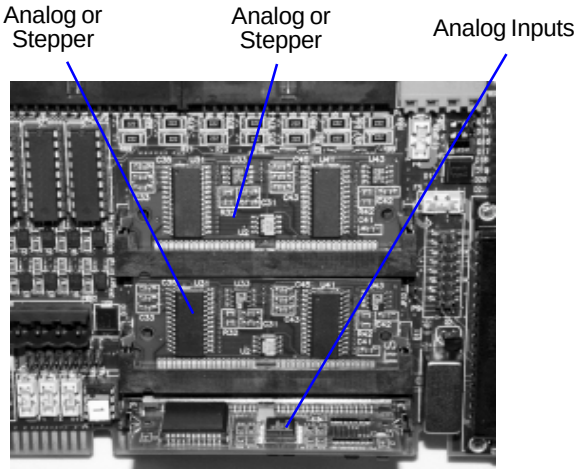
Because of the ACR controllers' standard on-board operating system, time-critical events can be off loaded to the controller. This is important, since the loading and therefore timing issues of the host PC CPU are variable and the programmer cannot be sure of real-time execution.

Pre-Emptive Multi-Tasker Features

- Perform up to 8 motion programs (25 usec/axis servo update rate).
- Perform up to an additional 8 programs (non-motion programs).
- Perform up to 8 PLC programs (1-5 msec scan time).
- Command up to 4 communication ports simultaneously
- Perform motion programs, PLC programs, and multi-threaded communications simultaneously.
- Troubleshoot from one port while the standard communication port is active with the HMI.
- Communicate over the PC-Bus, and two serial ports simultaneously.
- Real-time application programming can be off-loaded to the ACR controller to ensure real-time execution.

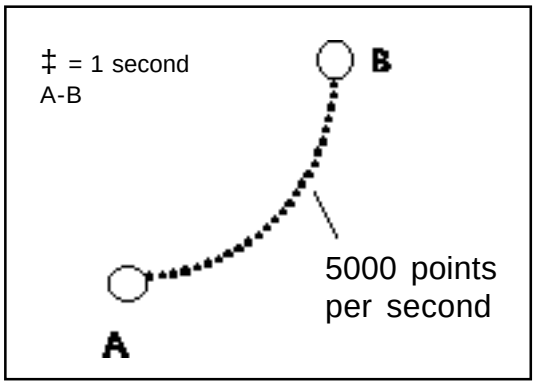
Analog/Stepper Flexibility

The Acroloop Motion Controllers can be set up to accommodate stepper or servo analog outputs. The controllers can be configured in combinations explained in the ordering matrix you find within each ACR category. Analog inputs at 12 or 16-bit resolutions are available as options. These may be field configured as single-ended or differential inputs.



Trajectory Calculation

The ACR's architecture permits extremely accurate trajectory calculations. Unlike other controllers, the ACRs calculate a new trajectory point with every interrupt; it can be calculated as frequently as every 100-1000 microseconds (compared to 5-10 milliseconds with other controllers).



Calculating a new trajectory every interrupt is the method of choice when the process consists of normal motion geometries.

Trajectory Calculation Table

Number of Axes	Calculation Bits	Trajectory Points/Second
2	64	5,000
4	64	3,333
6	64	2,500
8	64	2,000

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Cubic Splines

ACR controllers provide cubic spline interpolation. Highlights include :

- Smoothness of continuous first and second derivatives of position
- Ability to handle uniform and non-uniform data points
- Ability to define initial and final velocity to blend with other motion profiles
- Goes through data points precisely
- Spline interpolation can be time-based or velocity-based.

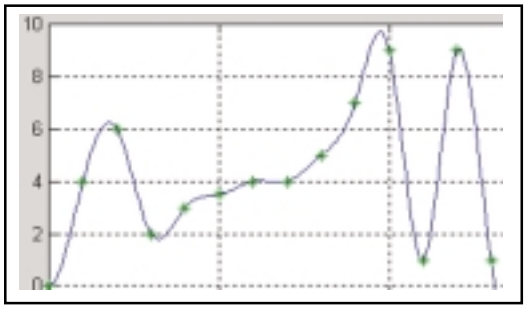


Figure 1. Example of how points can be randomly spaced in time, greatly reducing program length.

NURBS

ACR controllers provide Non-Uniform Rational Basis Splines, or NURBS. NURBS are industry standard tools for the representation and design of geometry. These give ACR controllers a mathematical method for defining an entire curve of up to eight axes. Highlights include:

- Free-form curves can be accurately defined
- Suitable for high-speed machining up to eight axes
- Gives better surface finish
- Shorter program and fewer data points
- No break between points at high speed
- No need for high-speed data transfer from the host
- No error due to approximating NURB curve by smaller linear line segments.

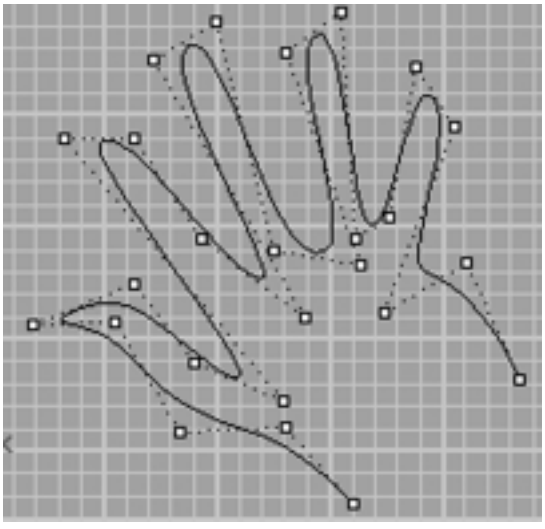


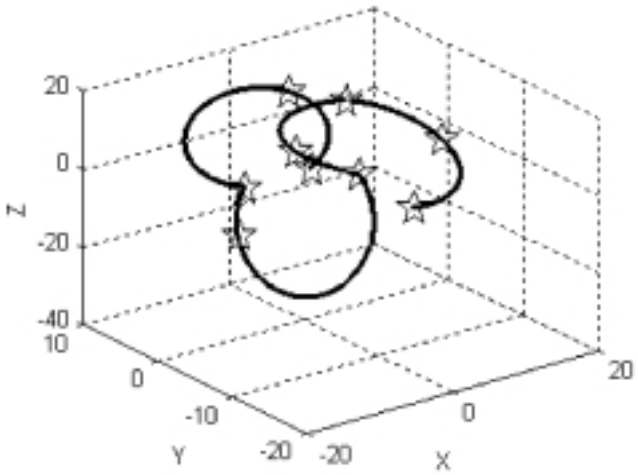
Figure 2. Example shows few control points needed to draw random shape and accompanying program.

Splines and NURBS Additional Features

- Dynamic Feed Rate override
- Feed Hold and Cycle Start facility, like normal moves
- Any source with source scaling, like normal moves
- Blending with other motion profiles; allows normal line/arc move at the beginning or end of spline/NURB segment
- Unique mix of modes only offered by Compumotor.

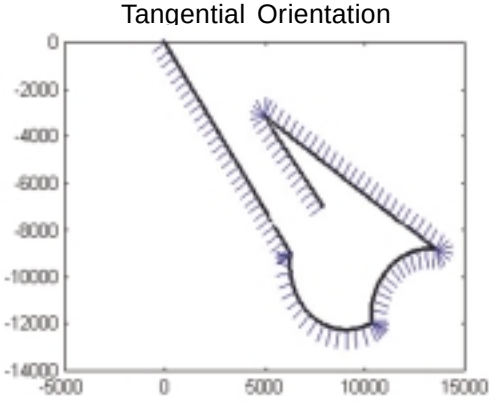
3-D Arc Generation

A three-dimensional arc-generation command built into the ACR controllers allows users to take 3D arc segments from a CAD system and create a three-dimensional circular interpolation using any three of the axes attached to the master. In this mode, the 3D arc is defined by a start point, an intermediate point and an end point of the arc. These points can be specified as incremental or absolute position. For successive 3D arcs, the end poimt of the arc is used as the start point of the next arc.



Automatic Tangential Orientation

The Automatic Tangential Orientation feature automatcially orients a theta axis to a user set angle along an X-Y path. Rather than jump at discontinuous geometries, the control delays the next move and waits for the theta axis to orient.



TANG Z X Y ANG 90
This command will hold the tool at 90 degrees along the path above.

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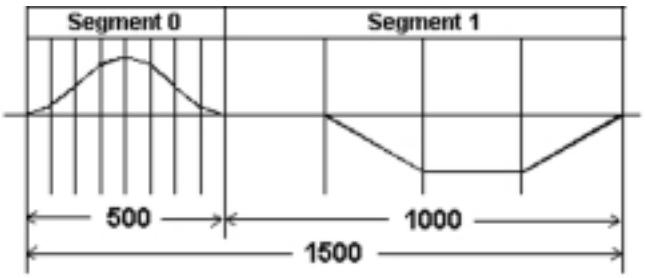
CAM – Electronic Cam

The CAM command is used to create motion that emulates a mechanical cam. The ability to segment the CAM gives the programmer flexibility. The CAM profiler will automatically linearly interpolate between any two points regardless of the density of the points.



TRG CAM – Triggered Cam

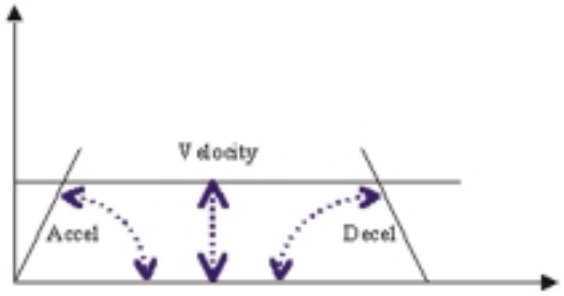
The TRG command solves the problem of following error due to the time delay between a triggered input and the actual start of physical motion. For example, if a web line is moving at 60 feet per second and there is a 2-microsecond hysteresis before motion takes place, the result will be an error:

60ft/sec x 12in/ft = 720in/sec x .002sec = 1.44 inches of error

The TRG CAM command negates this and therefore increases repeatability and accuracy to within on microsecond. Barring mechanical limitations, the electronic accuracy is now improved by a factor of 2000 to 0.007".

TMOV – Time-Based Move

The TMOV command allows moves to be completed in a specific amount of time. Prior to TMOV, the programmer would need to program with a calculator to determine the speed, acceleration and deceleration needed to arrive at a destination in a specific amount of time.

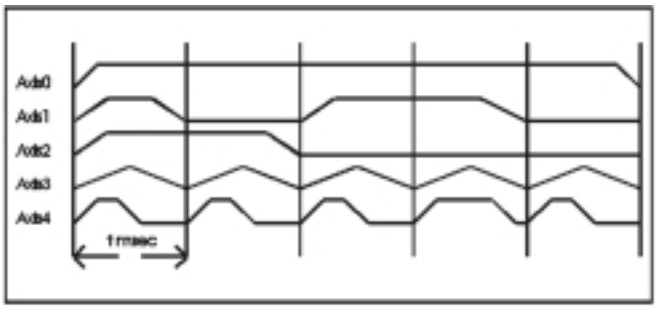


Once Velocity, Accel and Decel are set on the default settings, TMOV will calculate Velocity, Accel and Decel based on length and time of move.

SYNC – Master Synchronizing

It is sometimes necessary to run several coordinated groups of axes' masters in synchronization with another master. In sewing, for example, if an X-Y table is under a needle, the table can only move when the needle is up and out of the fabric. In this example, the SYNC command can be used to coordinate the movement of the needle to the movement of the table.

Using SYNC moves rather than coordinated moves gives users the flexibility of using different motion profiles for different masters while still keeping them in sync.



The figure above shows a velocity vs. time graph for five axes attached to different masters that move with independent accelerations and decelerations, yet are synchronized amongst themselves. They all complete their moves within the prescribed time interval of tmsec specified by the user. This mechanism can be useful in coil-winding applications when the wire feed moves continuously yet other axes must come and go at their own pace while remaining synchronized to the wire feed.

Backlash and Ballscrew Compensation

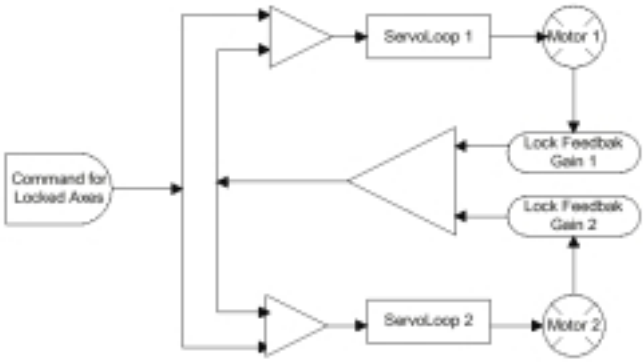
Backlash and Ballscrew Compensation allow the user to electrically compensate for the inherent inaccuracies of their mechanical systems. The Backlash Compensation simply takes into account the mechanical backlash when changing direction on the mechanical system. Once the backlash value is entered into the system, the ACR controller automatically compensates for lost travel due to backlash when changing direction, thus ensuring accurate positioning. The ballscrew compensation feature allows the user to map the inaccuracy of the mechanical actuator along the entire travel length required by the application. Once this inaccuracy is mapped, the ACR controller automatically compensates by cross-referencing the correction map and adjusting the commanded position of the axis to ensure the actual desired position is reached on the load itself. This capability allows the user to eliminate the costly linear encoder often used to compensate for mechanical variations along the travel of the actuator.

Dual Feedback Control

The Dual Feedback capability of the ACR products allows the user to close two loops of feedback around a single mechanical axis. One encoder is found on the servo motor and another on the load itself. This allows the ACR controller to automatically compensate for the inherent mechanical compliance within the traditional screw driven actuator. The position loop is closed with the load encoder while the velocity loop is closed with the motor encoder. This ensures the most accurate positioning possible while maintaining stiffness required for aggressive acceleration and velocity moves.

LOCK – Gantry Lock Control

The LOCK command redirects one axis to follow the primary setpoint of a second axis. This command is essential for controlling a gantry system where two mechanical systems need to be coupled. Once the two axis are locked, a special control loop will minimize the error between the two axis assuring perfect coordination.

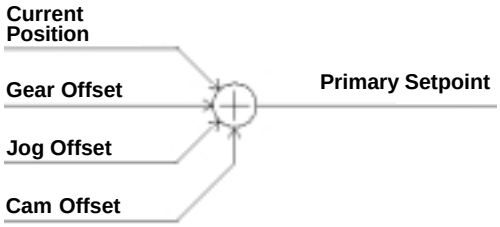


LOOK – Dynamic Multi-block Look Ahead

In many machining and assembly operations, it is essential that overshoot be minimized in order to maintain quality and finish in the part being produced. The LOOK ahead command dynamically analyzes upcoming move parameters to assure that the system can perform the desired move. If the moves are too demanding for the system to execute, the move profile will automatically be limited to the maximize speed that can complete the desired move.

Simultaneous CAM, Gear and Jog

The unique setpoint summation technique of the ACR controls allows up to 3 different move profiles to be superimposed onto a commanded move. This unique technique allows the machine builder to accommodate for changes in environmental conditions such as temperature and will allow a cam profile to be advanced or retarded very simply. ACR controllers allow easy integration into vision systems by allowing offsets measured by the camera to be superimposed “on the fly” without the need of changing a distance parameter and making an additional move.



Floating-Point Mathematics Precision

Provided with 64-bit precision floating-point math functions, ACR controllers give you:

- Six “decimal” digit numbers as standard and 16 “decimal” digit floating-point numbers to provide greater accuracy
- Global and local variable operation
- Simultaneous performance of intermediate calculations for trajectories, parametric evaluations, PLC operations, high-speed position captures and many other tasks.

Compare the 32-bit and 64-bit precision floating-point variables to other motion controllers; you won’t get rounding errors with the ACR controllers. For example, a simple electronic gearing ratio can be set to a floating-point number unlike other controllers with limited gear ratio ranges. If a PC host is used, it only requires updating the graphical display and feeding new operator information to the motion controller; the ACR controllers take care of everything else.

Simultaneous Port Access

The ACR controllers are unique since they can communicate both ASCII and binary simultaneously. Benefits of this "two access doors approach" include:

- Unrestricted integration of front-end software designs
- Simple ASCII codes can be transmitted to the board over any of the on-board communications ports (COM1, COM2, LPT and the PC-bus)
- Communications can be increased dramatically to allow increased data throughput to and from the controller.

Hardware Parameter Access

ACR firmware is engineered for maximum flexibility with an open design allows designer complete access to virtually every possible motion control parameter and flag. There are up to eight masters and up to eight axes on an ACR controller. A master controls a group of axes; therefore, each master controls a unique group of variable that can be monitored or changed on-the-fly.

Table A: Master Parameters Examples

Position Parameters	Type	MASTER0
Vector Position	FP32	P8192
Vector Velocity	FP32	P8193
Vector Acceleration	FP32	P8194
Vector Jerk	FP32	P8195
Vector Length	FP32	P8196
Target Velocity	FP32	P8196
Target Acceleration	FP32	P8197

Table B: Axis Parameters Examples

Position Parameters	Type	AXIS0
Current Position	LONG	P12288
Target Position	LONG	P12289
Actual Position	LONG	P12290
Following Error	LONG	P12291
Hardware Capture	LONG	P12292
Software Capture	LONG	P12293
Primary Setpoint	LONG	P12294
Secondary Setpoint	LONG	P12295

Tables A and B illustrate the Master and Axis parameters. For example, the vector velocity for MASTERprofiler 0 is stored in hardware parameter number P8193. Variable P8193 is a 32-bit floating-point variable. If the programmer wanted to display the current position of AXIS0 on the operator display, a request would be made to the ACR controller to retrieve the 32-bit-long integer stored in hardware register P12288. There are approximately 15,000 parameters pre-programmed into the ACR controllers.

HSINT – High-Speed Uninterruptible Move

The HSINT command gives the programmer a way to initiate an incremental move based on an input. On webs it is common to initiate motion on the leading edge of a marker.

With the command, one needs to define a target position, then a window. Then point to an input and the controller will initiate the incremental move once it reaches the correct state. All this is accomplished at high speed due to the 1-microsecond latching of any input or parameter

PLS – Programmable Limit Switch

The PLS command allows sequencing an output parameter (usually physical I/O bits) based on the changing values of an input parameter (usually an encoder). The simpliest PLS is used in most drum sequencers found in washing machines to control wash cycles.

The ACR PLS allows user to:

- Select from a variety of output parameters
- Advance and retard the source parameter and mask and scale the output parameter
- Control the number of I/O bits the PLS operates on.