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GALIL MOTION CONTROL

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"The mission of Galil's experienced Applications Department is to provide prompt and accurate technical assistance to help OEMs successfully deliver their products to market."

GALIL SUPPORT TEAM

Galil offers many standard options for its motion controllers, drives and PLCs.

From top:
DMC-40x0 Accelera controller,
DMC-21x3 Econo controller,
DMC-18x6 PCI controller and
RIO Pocket PLC

Galil Offers Many Controller Options to Accommodate Any Application

While Galil motion controllers come standard with high-performance features, many options are available to accommodate virtually any application. Standard options include interface to various forms of encoder feedback such as resolvers, SSI and BiSS; specialized compensation for ceramic motors; backlash and leadscrew compensation; commands for laser control applications; anti-resonance compensation; S-curve acceleration; customized coordinate transformation; alternative communication protocols and much more.

The most common options are listed on page 2. Detailed articles highlighting options for Alternative Feedback, Laser Control, and Coordinate Transformation are included in this issue of ServoTrends. Please consult a Galil application engineer to discuss these options or other special requests. Galil controllers can also be customized to meet your specific requirements no matter how complex or unique. ■

Please see http://www.galilmc.com/products/upgrade-options.php for more information.

List of Standard Options

Alternative Feedback/Encoder Options

Standard Feedback is incremental encoder (sinusoidal, quadrature or analog)

SSI

BiSS

SPI

Yaskawa

Resolver

Distance Coded Index

Parallel

Motors

Standard interface is for stepper, brushed servos or brushless servos

Ceramic

Hydraulics

Extremely accurate, high-velocity air bearing spindle motors

Compensation

Standard compensation is PID with velocity feedforward and acceleration feedforward

Two Sets of PID

Anti-resonance profiling

Backlash and Leadscrew compensation

Advanced dual loop

Profiling

Standard modes of motion include point-to-point, linear and circular interpolation, gearing, electronic cam, contouring, position tracking, teach and playback

S-Curve

Modular Moves

PVT (position-velocity-time)

Coordinate Transformation

Communications

Standard Communications include PCI bus, Ethernet, and RS232

Unique RS485

Custom Ethernet Protocols

Custom Data Record

Custom Data Logging

Laser Control

PWM output

Frequency and Duty Cycle Modulation

FIFO Pulse Control

Coordination with Vector Motion

Pulse Window Control

Pixel Generation

Amplifiers

Custom gains

Special Voltage Range

Special Current Output

Custom Microstep Resolution

Stepper/Servo Mix

Other

Encoder Failure Detection (standard on DMC-40x0)

Password Protection (standard on DMC-40x0)

Expanded Memory (standard on DMC-40x0)

Custom Default Parameters

Software

Private Label

Custom APIs

Custom Options

Galil controllers can be customized to meet your specific requirements. Consult Galil for details.

Please see http://www.galilmc.com/products/upgrade-options.php for more information.

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Laser Control Options

By DJ Roberts, Galil Applications Engineer

Galil Laser Control options focus around a group of specific application requirements found primarily in laser marking, inscribing, raster imaging, and intensity control. Although lasers are particularly suited to these modes, many other technologies are applicable, including focused ultrasound, imaging and high speed inspection, and plasma and water cutting.

The typical mechanical configuration for a Laser Control application is a two or three axis stage actuating a laser rail. The control signal for a laser application is typically a PWM (Pulse Width Modulated) digital signal at a particular frequency and duty cycle ***(see Figure 1)***.

Figure 1: 50% duty cycle PWM with an increasing frequency.

Controlling the characteristics of this control signal can affect the operation of the emitted beam in various ways ***(see Table 1)***.

Table 1: Laser Control

Beam Characteristic	Description of Modification	Effect
PWM Duty Cycle	The on-time of the signal can be modified from 0 to 100%	The on-time can affect the mark radius and line thickness of a beam's result.
Pulse Frequency	Vary the frequency of the PWM	The intensity of a laser can often be controlled with frequency. This allows for various grayscale or even color imagery, and control of depth of cut.

Galil can provide precision generation of the laser control signal. Hardware acceleration and firmware integration provide high performance control that is accessible to the standard motion features of the Galil command set. ➤(cont. pg 4)

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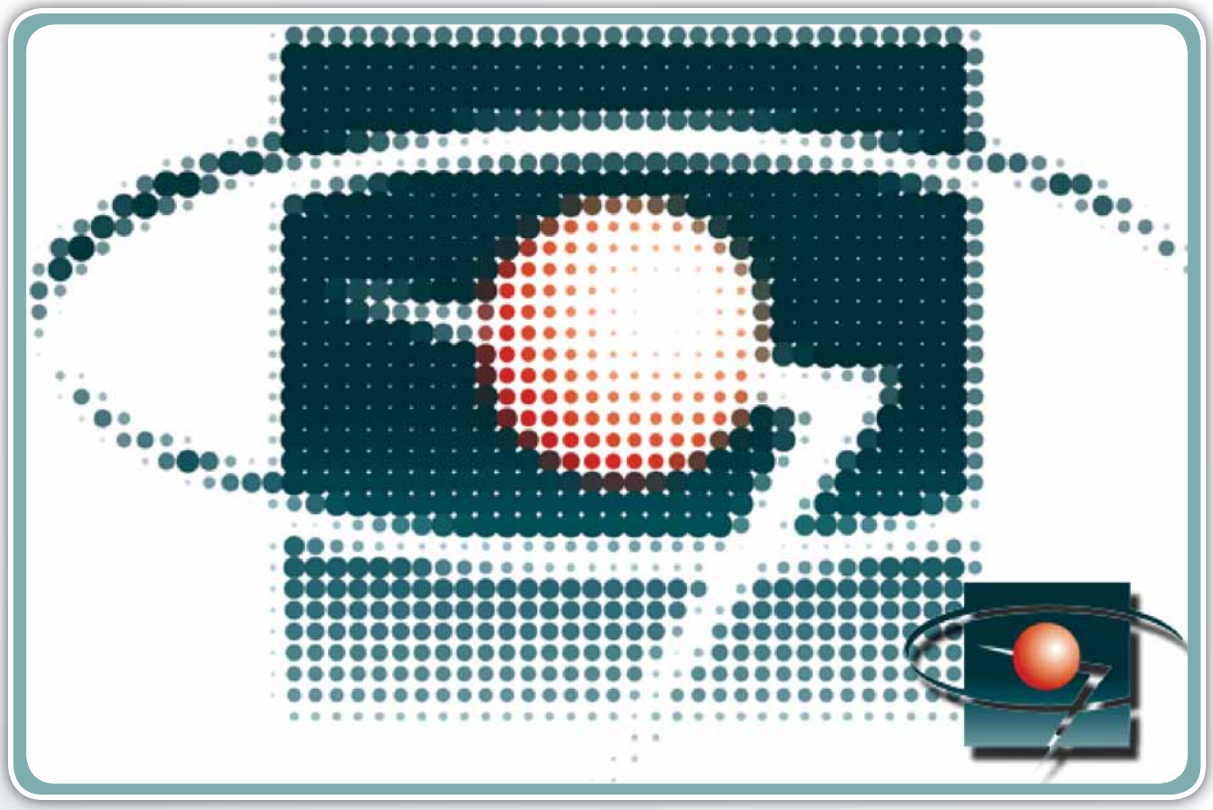
Once dynamic modification of laser characteristics is possible, a whole new world of options is opened up allowing for very sophisticated motion control. The Galil pulse-on-position, also called output compare (See OC in the Command Reference), provides a super-accurate, hardware-based position synchronization for lasing the substrate at an exact position. A laser imaging application might use PWM and Frequency control in concert with pulse-on-position to form a pixel-based raster image ***(see Figure 2)***.

Figure 2: The pixels of the Galil logo have exact horizontal and vertical centers as a result of Galil's output compare. The pixel radius is controlled by the PWM duty cycle of the laser control signal when it is pulsed. The differences of pixel radii provide for the effect of image brightness.



To provide for the fastest possible performance, the stage must be moving at as fast a speed as mechanically possible. This can be accomplished by providing a hardware-based pixel queue, or FIFO (First In, First Out). Similar to a raster image processor (RIP) found in laser printers, an image can be transferred into pixels, with the requisite information including physical location of pulse, PWM duty cycle, and even PWM frequency. This serves as a laser "bitmap" that can be queued and dequeued quickly from hardware to allow for even the fastest motions.

There are many, many more features available in Laser Control Options offered by Galil. To discuss the options available for you application, including the details above, precise active-window control, vector speed synchronization, and more, contact Galil's Applications Department today. ■

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Coordinate Transformation Options

By Todd Shearer, Galil Applications Engineer

Summary

Galil now offers users the option of ordering motion controllers with on-board Coordinate Transformation. This option allows a user with a complex kinematic transform to have that calculation performed directly on the Galil controller. Working with a Galil application engineer, the user will review the forward and reverse kinematic transformation for their particular machine. These equations are then written into the firmware of the Galil controller. The end result of this process is that the transformation now occurs upon the calculation of each servo update (up to 32kHz), and the user can command the system in machine coordinates rather than simple encoder counts. In addition, this saves the PC from the burden of performing these sometimes complex calculations.

Benefits

There are many benefits to the Galil implementation of coordinate transformations. First, with the transformation operating in firmware space rather than user software space, the transformation is able to run quickly and deterministically on each servo update. There is no latency or variability to the rate of calculation. Second, as the transformation is handled within the firmware, the user software space is available and unburdened by the overhead of complex transformations. This allows for faster execution of software routines for other aspects of the application. Finally, as part of the implementation, Galil will consult with you about your specific application. This can lead to recommendations which may improve system performance and safety.

Required information

1. Detailed description of the mechanics to be implemented. This should include drawings and/or photographs of the specific machine.

2. Forward and reverse kinematic equations for the specific mechanics. If these have not already been derived, Galil application engineers will consult with you to derive those equations and make recommendations on the best possible approach.

3. Detailed description of the application and motions. This will include typical moves (point to point, constant velocity, high speed step/settle, etc), encoder resolutions, required keep-out zones, expected system bandwidth and any other information related to the motion of the machine.

4. System boundaries and other range of motion information. This allows the firmware to work within the usable space of the machine.

Examples of systems which require coordinate transformations are described on the following page.

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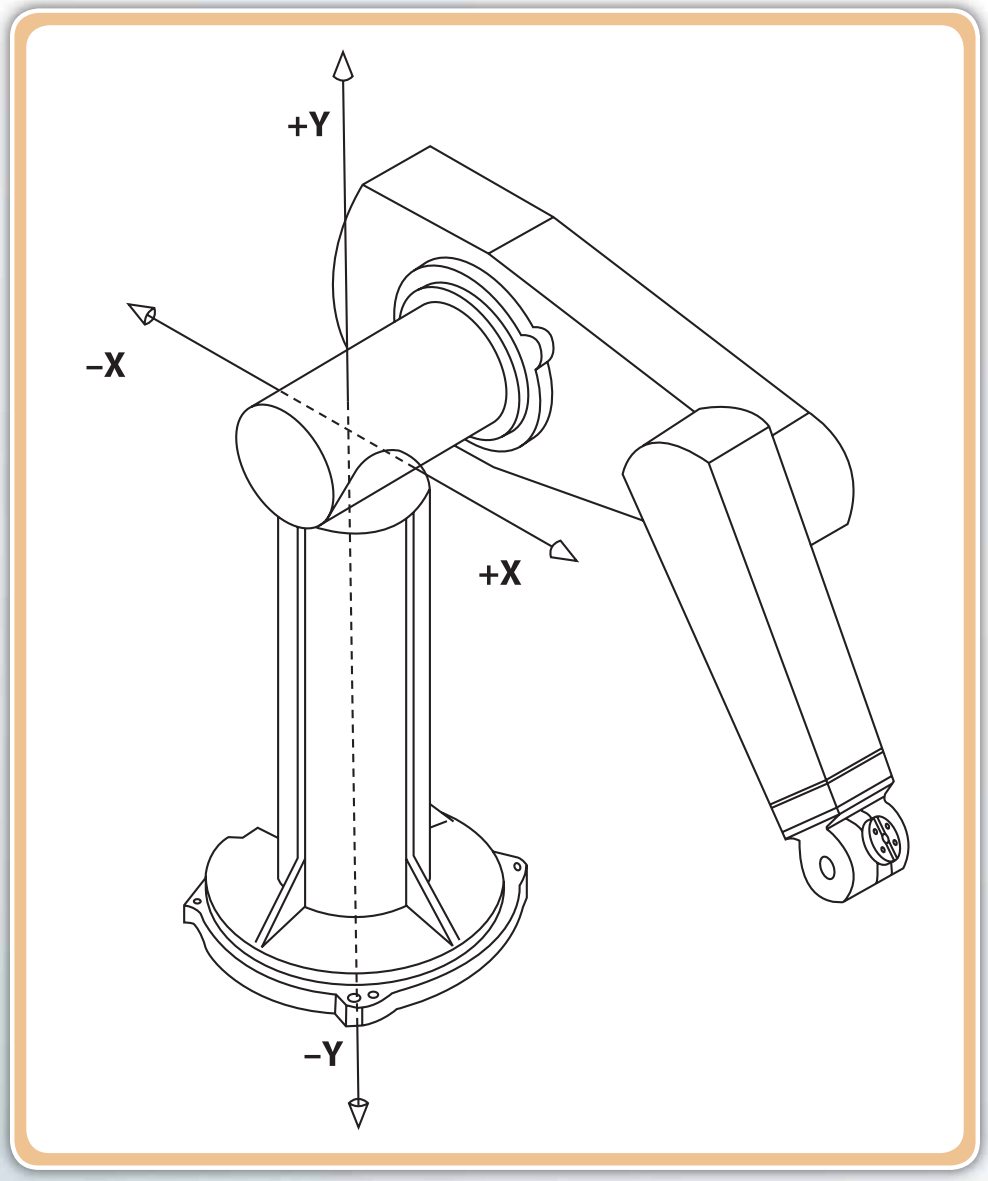
Examples

There are many examples of systems which require coordinate transformations for operation, but two of the simplest and most common are the hexapod and the SCARA robot.

1. Hexapod – A hexapod is a motion platform which has 3 points of contact from 6 individual axes. Imagine 2 linear actuators connected to each corner of a triangle, and you have the basic layout of a hexapod. A traditional hexapod will give the user 6 degrees of freedom (6 dof) in motion, and are commanded with coordinates of Yaw, Pitch, Roll, Heave, Surge and Sway. The equations of motion for a hexapod could be implemented into the Galil controller, allowing the user to program the controller in the standard 6 dof coordinate system rather than the individual axes (A,B,C,D,E,F,G) format.

2. SCARA robot – A SCARA robot is a standard positioning robot format which allows positioning of an end effector in the XY plane. The user is able to command motion to an XY coordinate, with the transformation converting this XY position to the required mechanics of the robot. ***Figure 1*** below shows a variation of the SCARA robot. ■

Figure 1:
Coordinate transformations are ideal for this 2-axis SCARA robot.



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Alternative Feedback Options

By Jason Rhodewalt, Galil Applications Engineer

A majority of motion control systems that include feedback will use an incremental encoder. The draw back to incremental encoders is that upon power up the controller does not know the position of the motor in absolute terms. To compensate for this, system engineers will home a system upon power up by driving the motor to a switch at a known location. This works well for many systems, but sometimes systems demand that the controller retain knowledge of the absolute position even during a power cycle. For these applications an absolute encoder is required.

> "Galil motion controllers have standard options for communicating to a number of different absolute encoder technologies."

Galil motion controllers have standard options for communicating to a number of different absolute encoder technologies. Resolver feedback is a common type of absolute feedback that has been used in motion control systems for a number of years. This can be advantageous in systems where the mechanics are subject to a harsh environment.

An older technology that is still used by some encoders is binary parallel encoders. These feedback devices work by toggling a specific number of bits that represent the absolute position to the motion controller. The draw back to a parallel encoder is that there is a wire for every bit, which can quickly become cumbersome when you look at encoders with 24 bits or more of resolution, especially with a multi-axes control system.

By far the most popular, SSI (Serial Synchronous Interface) feedback is offered by a number of different encoder manufacturers. The advantage to SSI technology is that it is quickly becoming an industry standard due to its ease of use and simple set up. Besides power and ground, there is only a clock and a data signal that need to be connected. Building on SSI, some encoder manufacturers support a BiSS (Bidirectional Serial Synchronous Interface) protocol. These encoders offer the ability for the encoder to store information locally and transmit them to the motion controller. This builds on SSI which only allows encoder position information to be transmitted.

Another new-comer to the encoder protocol world is the Distance Coded Index. These types of encoders are quasi-absolute. The encoder track is lined with various index pulses that are specific distances apart. Upon power up, with two short moves in either direction, the encoder can read the index pulses and determine the absolute position.

There are many types of encoder protocols to choose from in the current marketplace and Galil motion controllers offer you the flexibility to choose the one that meets the needs of your system. If you do not see the type of interface you require listed here, call Galil's applications engineers to review your selected interface. ■

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Galil. We Move the World.

With over 500,000 controllers installed worldwide, Galil is the leading supplier of motion controllers. Galil's legacy of innovation began in 1983 with the introduction of the first microprocessor-based servo motion controller. Today, Galil continues its leadership by offering the most powerful, cost-effective and easy-to-use controllers to accommodate all your motion and I/O needs.

Galil offers a broad array of motion controllers in a variety of formats: single and multi-axis, card-level and box-level, bus-based and stand-alone. Galil's Ethernet/RS232 and PCI controllers are available in an Econo version for lowest cost and Accelera version for ultra high-speed performance. Plug-in, multi-axis drives for steppers and servos save space, cost and wiring. For intelligent I/O control, the RIO Pocket PLC is compact, low-cost and packed with analog and digital I/O.

At Galil, we share our expertise with our customers. You will find a wealth of information on our website at http://www.galilmc.com. Here you can view any of Galil's free web-tutorials, read an application note or white paper, post a question on our bulletin board, or download the latest software and manuals.

Exceptional application support is a top priority at Galil. Call Galil today at 800-377-6329 to discuss your project with one of our highly-trained applications engineers. ■

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ACCELERA CONTROLLERS AND DRIVES

DMC-40x0	Ethernet/RS232
DMC-18x6	PCI

ECONO CONTROLLERS AND DRIVES

DMC-21x3	Ethernet/RS232
DMC-18x2	PCI

SINGLE-AXIS CONTROLLERS AND DRIVES

DMC-1415	Ethernet/RS232
CDS-3310	Ethernet/RS232

POCKET PLC I/O CONTROLLER

RIO-47xxx	Ethernet/RS232

SOFTWARE TOOLS

GalilTools. Servo Tuning and analysis software

Ladder Interface. Converts Ladder program into DMC code for RIO Pocket PLC.

Check in daily with Galil Motion Control on LinkedIn, Twitter and Facebook!

FREE	Online Support Tools
✓	Application notes, white papers and industry articles http://www.galilmc.com/support/application-notes.php
✓	Over 20 tutorials about servo tuning, motion programming, & motors and drives http://www.galilmc.com/learning/tutorials.php
✓	MotionCode™ Toolkit, step-by-step solutions with downloadable code http://www.galilmc.com/learning/motioncode.php
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