Galil Expands Controller n’ Drive Sandwich Offerings with New AMP-20540 Amplifier Board for Driving 500W Motors

Galil’s family of DMC-21x3 controller/amplifier “sandwiches” continues to expand with the addition of their new AMP-20540 amplifier board designed for driving four brushless or brush-type motors up to 500 watts. Like the other DMC-21x3 multi-axis drives that Galil offers, the AMP-20540 attaches directly to the 96-pin DIN connector of the controller without any need for a cable. This gives OEMs a cost-effective, multi-axis controller-and-drive solution that eliminates any wiring between the controller and drives. This multi-axis controller/amplifier “sandwich” combination also provides a lower cost alternative to using separate single-axis controllers and drives by eliminating the complex software needed to coordinate the axes.

This multi-axis drive solution is priced at only $495 in 100 quantity for the four-axis model of the AMP-20540. When combined with a DMC-2143 four-axis controller ($795 in 100 quantity), the amplifier/controller price per axis comes to less than $325. Since the AMP-20540 attaches directly to the DMC-2143, there is no additional cabling or interconnect hardware required, which provides even greater savings.

The new AMP-20540 contains four-transconductance, PWM amplifiers on a single board that measures only 6.92” x 4.85”. Each amplifier can drive either brush motors or 3-phase brushless motors up to 500 Watts per axis. Also, the AMP-20540 accepts 18V to 60 VDC and produces 7 amps of continuous current. The PWM switching frequency is 60 kHz.

The AMP-20540 provides several other special features for diagnostics and setup via the DMC-21x3 controller, including:
- Protection against over-current, short-circuit, under-voltage, over-voltage and over-temperature. Errors and status can be interrogated via the DMC-21x3 controller using a new command, TA
- A new command, BS, allows for easy set-up of hall sensors and ensures that the brushless phases are properly aligned
- Programmable amplifier gain settings of .7, .4, or .2 Amp/Volts using a new command AG
- Eight, uncommitted analog inputs (12-bit ADC standard, 16-bit optional) for the DMC-21x3 controller

Additionally, the AMP-20540 uses 15-pin high density D-sub connectors for encoder, hall sensors and home for each axis. A single, 44-pin, high-density D-sub connector is used for limits and additional I/O signals; and a 4-pin Molex is used for the DC voltage input from a single DC power supply of 18-60 Volts.

(Continued on Page 2)
A Guide To the Motor Options for Galil Controller n’ Drive Sandwiches

Galil’s new family of DMC-21x3 Ethernet controller and amplifier sandwich combinations provide a cost-effective solution for OEMs. When combined with the appropriate motors, the designer has a high-performance, multi-axis, low cost solution that lessens the burden on the host computer as opposed to coordinating single-axis components.

This enables OEM designers to reap the benefits of the recent advances in motor and sensor technology that are improving performance and reducing prices. For example, it’s now possible to purchase high performance N23 brushless motors with encoders for less than $150. When combined with a DMC-C-2143 four-axis controller and AM P-20540 four axis drive, the total cost per axis for the combined controller/drive/motor/encoder solution is less than $500 for quantity purchases.

To help you guide you with motor selection, Galil has compiled this partial list of servo motor manufacturers. Please note this is just a sampling of the manufacturers and motors that are compatible with Galil’s AM P-20540 500 Watt servo amplifiers. As a further aid, Galil is developing a series of application bulletins that detail the specifics of connecting various motors to the DMC-21x3 and drives. Please see http://www.galilmc.com/literature/technotes.html for additional information.

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<tr>
<th>MOTOR MFG</th>
<th>WEB ADDRESS</th>
<th>EXAMPLE MODEL NUMBER</th>
<th>MOTOR TYPE</th>
<th>CONTINUOUS TORQUE OZ.-IN.</th>
<th>MAX SPEED RPM</th>
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<tr>
<td>Galil</td>
<td><a href="http://www.galilmc.com">www.galilmc.com</a></td>
<td>BLM-N23-50-1000</td>
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<td>Applied Motion Products</td>
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Today’s machine designer is in the fortunate position of having a wide range of motion control options to select from. However, choosing the best controller for a specific application is often confusing. The following reviews the various choices for motion control and presents the pros and cons of each.

**Single-Axis, “Intelligent Drives”**

“Intelligent Drives” are single-axis, digital amplifiers that contain a basic position controller that closes the servo loop and accepts position data in the form of a contour data stream. These drives interface with the host computer via RS232, CANopen, Ethernet or an alternative communication protocol. Intelligent drives are typically used for single- or 1–1/2-axis applications that do not require coordination. They offer cost and space savings for single-axis projects by often eliminating the need for a separate controller.

Intelligent drives can also be used for multi-axis, distributed control applications where each amplifier is placed in close proximity to each motor. The advantages of the distributed approach is that the designer has the flexibility for matching specific drives to individual axes and can eliminate the long wires that connect to a multi-axis, central controller.

The major disadvantage of using single-axis intelligent drives for multi-axis applications is that the host is burdened with the complex task of synchronizing amplifiers for precise motion coordination. This also puts the burden of coordinated motion control on the system designer. Another disadvantage is the large communication burden placed on the host to talk to the various drives.

**Single-Axis, “Intelligent Motors”**

When a motor, encoder, drive and controller are combined in a single package, it is often called an “Intelligent Motor”. Like intelligent drives, these intelligent motors are ideal for single-axis applications and they provide a significant savings in cost, space and wiring.

Many users find the intelligent motor solution convenient since all components come from one supplier and work together seamlessly. The disadvantage of using one supplier, however, is that users cannot mix-and-match components from different vendors and, therefore, cannot pick the very “best-in-class” for each component.

Also, the intelligent motor solution becomes more costly and complex for multi-axis applications requiring motion coordination. As with intelligent drives, the intelligent motor solution puts the burden of axis synchronization and coordination on the host computer.

**Bus-based Multi-axis, “Intelligent Controllers”**

Intelligent Bus-based motion controllers fit inside a computer I/O slot such as the PCI bus. They are typically available in multi-axis formats where the control is centralized onto a single card. For example, a single eight-axis controller card can command eight separate drives and motors.

Unlike distributed, single-axis solutions, centralized controllers relieve the host from the intense burden of motion coordination. Also, the communication burden between the host and controller is reduced. Additionally, there is a significant cost savings with a multi-axis controller as compared to purchasing multiple single-axis controllers. This is because the incremental price per axis drops with each axis added to a central controller.

(Continued on Page 4)
The main disadvantage of bus-based, central controllers is the connectivity and wiring complexity required for interfacing them to various drives and motors. For example, the computer which contains the central control card may not reside close to the motors and drives. This results in long wires. Also, the bus architectures are at the mercy of PC vendors as there may be a limited number of bus slots available. There is also the issue of the format perhaps becoming obsolete like the ISA bus.

Serial Multi-axis, “Intelligent Controllers”

Serial, multi-axis controllers are designed with a RS232, USB or Ethernet serial link, and they do not have to reside inside a PC bus slot. This gives the designer more flexibility in controller placement and less dependency on PC manufacturers. Also, with Ethernet readily available on most PCs, there are numerous devices available for this commonly used, low-cost network.

Like other central controllers, a serial, multi-axis controller will relieve the host computer and programmer from the time-intensive and complex task of motion coordination. Also, the designer can mix-and-match motor types and choose the best drives and motors for their application. Unlike distributed control systems, central controllers tend to have more complex and longer wires going from the central controller to the various drives and motors.

Centralized Multi-axis, “Intelligent Controller/Drive” Combinations

Galil’s DMC-C-21x3 Ethernet controller series is an example of an intelligent and centralized multi-axis controller that is sandwiched with a multi-axis drive. As with other central controllers, the DMC-C-21x3 accomplishes all motion coordination tasks. Some of the wiring complexity typical with other central controllers is eliminated because multi-axis amplifiers are attached directly to the controller without any cabling. Also, multi-axis amplifier boards are more economical than purchasing separate single-axis drives, which results in a significant cost savings.

However, multi-axis amplifiers are less flexible for applications that require a different drive style for each axis. This new breed of multi-axis, intelligent controller/drive combinations provide the best advantages of both distributed and central control schemes by providing the designer with a cost-effective solution with reduced wiring and minimal burden on the host.
Distributed Multi-axis, “Intelligent Controller/Drive” Combinations

Another approach for motion control is to construct a distributed control system using multi-axis controller/drive combinations. Unlike traditional distributed control systems which use single-axis controller/drives, a distributed control system using multi-axis controller/drives takes the tasks of motion coordination off the host computer. Also, the designer has more flexibility by being able to choose the number of controller axis combinations best suited to the application.

For example, the user might design a 16-axis system using four 4-axis controllers, two 8-axis controllers or eight 2-axis controllers. These are then distributed on a single network such as Ethernet. One controller can even be designated as the master over the other controllers. The master would receive commands from the host computer and then distribute appropriate commands to each controller in the network. This provides the advantage of reducing the communication burden for the host computer. Another advantage is that multi-axis controller/drives are more economical than multiple single-axis products. Further cost and complexity reductions are achieved because the controller and drive are combined as a single unit.
Galil has built an extensive library of technical web-tutorials that expound on a variety of motion control subjects including servo tuning, dual loop control, and motor types. Just recently, Galil revised their DMC-21x3 Ethernet Controller tutorial to cover such new DMC-21x3 options as plug-in I/O modules and multi-axis amplifier boards for stepper and servo motors. These boards attach directly to the DMC-21x3 motion controller without a cable to provide improved connectivity and significant cost savings. Also added is a new tutorial on servo amplifier technology. Go to [http://www.galilmc.com/training/webconf.html](http://www.galilmc.com/training/webconf.html) to view these new tutorials, as well as any other of the Galil tutorials listed below. Tutorials are available 24/7 and at no cost to registered viewers.

### Video Demonstration by Jacob Tal
- "Motion Controller Demonstration"

### TUNING
- "Tuning Servos for Best Performance"
- "Advanced Tuning Methods"
- "Dual Loop Compensation Methods"

### SYSTEM DESIGN
- "Modes of Motion"
- "Control of Load Sharing Systems"
- "Tension Control of Web Processing Systems"
- "Optimal Design of Motion Systems"

### ETHERNET
- "DMC-21x3 Ethernet Controllers and Drive Options"

### SOFTWARE TOOLS
- "ActiveX Tool Kit"

### MOTORS & DRIVES
- "Overview of Servo Amplifier Technology"
- "Piezo Ceramic & Ultrasonic Actuators"
- "Step Motor Control"
- "Brushless Motor Control"

### MISCELLANEOUS
- "Connecting to Galil I/O"
- "Controller Upgrade Options"
- "Overview of Galil Motion Control"

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### Jacob Tal Presents “Motion Control Made Easy” Seminar in Silicon Valley and Boston

Jacob Tal, the preeminent authority on motion control, will personally conduct his acclaimed motion control seminars this Fall season. The half-day Basic Seminar will be offered in Silicon Valley and in Boston. In addition, Galil’s two-day Product Workshop will be conducted at Galil headquarters in Rocklin, California. Course summaries, pricing and locations are detailed as follows:

**Motion Control Made Easy**
- Half-day (4 hours) $79
- Mon. 9/08/03 Santa Clara, CA
- Mon. 9/15/03 Marlborough, MA

This Basic introduction on how to successfully implement motion control systems covers such subjects as selecting system elements, servo tuning, programming and application examples. Also available on video and as a web-based training course.

**Product Workshop**
- Two-days $250
- In-house Workshop dates:
  - Aug. 4th & 5th; Oct. 20th & 21st

Users of Galil motion controllers will gain detailed understanding about connecting system elements, tuning, motion programming and troubleshooting. They can test their application on actual hardware and review it with Galil specialists. Attendees must have purchased and/or used a Galil controller.

Over 10,000 engineers have attended Jacob’s seminars to gain and expand their motion control knowledge and to increase their productivity. Your complete satisfaction is guaranteed or your money back. Call Galil at 800-377-6329 to reserve your seat or register on-line at [www.galilmc.com/training/seminars.html](http://www.galilmc.com/training/seminars.html).

Enrollment is limited. If a live seminar isn’t held near you, the half-day seminar is available on video or as a web-based training course.
Traditionally, power amplifiers for servo motors have been designed with continuous components. Such amplifiers, also known as drivers, achieve fast response and excellent performance.

In recent years, we have seen the growth of digital amplifiers. These devices include a microprocessor that performs such functions as closing the current loop, closing the velocity loop as necessary, performing commutation, changing the amplifier parameters, and performing diagnostics. The main benefits of the digital drive include:

- Ability to electronically change the amplifier parameters
- Diagnostics
- Additional functions like velocity loop and sinusoidal commutations

Digital amplifiers also have some disadvantages, with the main one being its cost. Adding expensive components significantly increases the amplifier price, especially when relatively low power is required. It should also be noted that replacing a continuous loop with a digital loop will only degrade the performance of the loop due to reduced bandwidth.

Today, a new type of amplifier is emerging, the hybrid. It combines the best features of the analog and digital amplifier by viewing the combination of the amplifier/controller as an integrated unit.

With the hybrid amplifier, the current loop is closed by analog circuits. The diagnostics are performed by the controller microprocessor while the changes in parameters are handled by the microprocessor and some dedicated circuitry. This results in a low cost, high performance amplifier with diagnostics and programmable parameter changes.

Galil’s first generation of hybrid amplifiers have the capability to detect four types of amplifier faults:

- Over Current
- Over Voltage
- Under Voltage
- Over Temperature

If a fault occurs, the controller automatically executes the amplifier error routine to handle the emergency. The amplifier status and error can also be interrogated through the controller. This also simplifies the tasks of the host computer.

The hybrid amplifier allows for two parameter changes: overall gain and current loop gain. Setting the amplifier gain provides a match between the amplifier and the motor, resulting in improved system resolution and better current limit protection. The second parameter, the current loop gain, controls the loop bandwidth and compensates for motors with high inductance.

Clearly, the hybrid amplifier optimally assigns the required tasks between the continuous components and the microprocessor, resulting in improved performance at a lower cost.
Galil. We Move the World.

With over 300,000 controllers installed worldwide, Galil is the #1 leading supplier of motion controllers. Galil’s legacy of innovation began in 1983 when they introduced the first microprocessor-based servo motion controller. Today, Galil continues its leadership by offering the most powerful, cost-effective and easy-to-use motion controllers to accommodate all your motion needs.

Galil provides you with the widest choice of single or multi-axis, bus-based or stand-alone, and box-level or card-level controllers. Interface options include PCI, ISA, PC/104, VME, cPCI, USB, RS232 and Ethernet. Select from 1-, 2-, 3-, 4-, 5-, 6-, 7- and 8-axis controllers, and configure them to run stepper or servo motors on any combination of axes.

Additionally, Galil provides various accessories that enable you to complete your project quickly. These include servo motors, amplifiers and software tools for quick set-up and “one-button” servo tuning.

**Motion Controllers – PCI**
- DMC-18x0. PCI, 1-8 axes
- DMC-18x2. PCI, 1-4 axes
- DMC-1417. PCI, 1 axis

**Motion Controllers – Ethernet/RS232**
- DMC-20x0. USB/RS232, 1-8 axes
- DMC-21x0. Ethernet/RS232, 1-8 axes
- DMC-21x2/x3. Ethernet/RS232, 1-8 axes
- DMC-14x5. Ethernet/RS232, 1-2 axes
- DMC-34x5. Ethernet/RS232, 1-2 axes
- IOC-7007. Ethernet I/O controller

**Motion Controllers – Other**
- DMC-12x0. PC-104, 1-8 axes
- DMC-13x8. VME, 1-4 axes
- DMC-16x0. cPCI, 1-4 axes
- DMC-17x0. ISA, 1-8 axes
- DMC-1410. ISA, 1 axis
- DMC-1411. PC/104, 1 axis
- DMC-1412. RS232, 1 axis

**Software Tools**
- **Communication Drivers.** For DOS, QNX, Linux and all current versions of Windows
- **SmartTerm.** Provides a friendly interface to all Galil controllers
- **WSDK.** Servo Tuning and analysis software
- **ActiveX Toolkit.** Custom controls for Visual Basic or other ActiveX software
- **CAD-to-DMC.** Translates AutoCAD DXF files into DMC controller files

For complete specifications and pricing on all Galil products, please go to [www.galilmc.com](http://www.galilmc.com).