

Galil Offers New Sinusoidal Encoder Interpolation Interface Board

Galil's new DB-28104 board is designed to mount directly (without any cable) to Galil's DMC-21x3 Ethernet motion controller, enabling it to perform interpolation of up to four sinusoidal encoders. Small in size at 3.510" x 3.075", the DB-28104 delivers much higher position feedback resolution, eliminating the need to purchase a more expensive, ultra high-resolution encoder.

Advantages

The DB-28104 achieves a much higher resolution than what can be realized with traditional quadrature type encoders.

Here's how: quadrature encoders output two binary signals that indicate the number of encoder counts detected by an optical sensor reading the encoder's optical disk. On the other hand, sinusoidal encoders build on the traditional quadrature encoder by interpolating the signal between each quadrature encoder pulse. Rather than outputting binary on/off signals, a sinusoidal encoder will output signals that vary continuously in a sinusoidal fashion, allowing one to achieve a much higher effective resolution by interpolating between each pulse.

Connecting the Encoders

The sinusoidal encoders connect to the DB-28104 through 9-pin D-sub connectors, with one connector required for each encoder. While the DB-28104 accepts both single-ended and differential encoder inputs, it is recommended that differential encoders be used instead of single-ended encoders because of their increased immunity to noise. Another advantage of differential encoders is that each signal has its own reference, meaning that if electrical noise is introduced, it generally is introduced on both differential lines. By reading the difference between these two lines, the effect of the noise cancels out. The alternative to differential encoders is using single ended encoders, which have one signal line that's measured with respect to a common ground. Though single ended encoders are accepted by the DB-28104, they are not recommended and may produce position errors due to signal bias. In addition to the two encoder input lines, the DB-28104 also accepts differential index signal inputs.



DB-28104 Sinusoidal Interpolation board attached to a DMC-2143 Ethernet Motion Controller.

How it Works

Traditional quadrature encoders work by having two sets of lines inscribed radially around the circumference of an optical disk. A light is then passed through each of these two sets of lines. On the other side of the gratings, a photo sensor detects the presence or absence of these lines. These two sets of lines are offset from each other so that one leads the other by one quarter of a complete cycle as shown in *Figure 1*. These signals are

commonly referred to as the A and B signals. The direction of rotation of the encoder can be inferred by which of the A and B signals leads the other. Each rising or falling edge indicates one quadrature count. Thus, for a complete cycle of the square wave, we read a total of four encoder counts, with one rising edge and one falling edge for each of the signals.

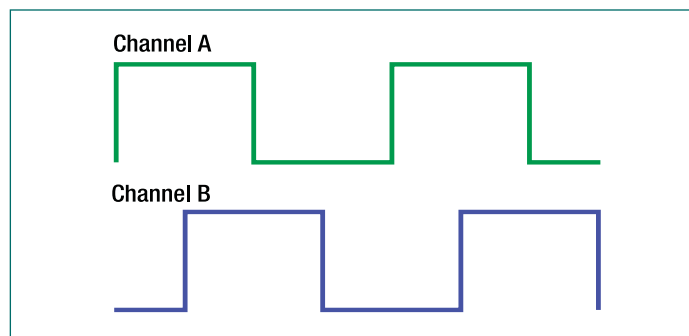


Figure 1: Quadrature Encoder Signals

A sinusoidal encoder is similar to a quadrature encoder in that it produces two signals that are read from two sets of lines inscribed on an optical disk. The difference is that the two signals are output as sinusoidal signals as shown in *Figure 2*. This allows one to interpolate the positions in between the lines on the disk, allowing it to achieve a much higher resolution than would have otherwise been possible.

The controller keeps track of the position at two levels. On one level, the number of coarse cycles is counted much in the same way as with a quadrature encoder. On the fine level, the precise position

(Continued on Next Page)

NEW Sinusoidal Encoder Interpolation Interface Board

(Continued From Previous Page)

inside the cycle is determined from the two sinusoidal signals using n bit interpolation. One can read the unique position within one cycle using the following equation:

$$\text{Fine} = \frac{2^n}{360} \tan^{-1} \left(\frac{V_b}{V_a} \right)$$

The overall position can be determined using:

$$\text{Position} = \text{Coarse_cycles} \cdot 2^n + \text{Fine}$$

Where:

n is the number of bits of resolution that were used in the conversion

Coarse_cycles is the whole number of cycles counted

Fine is the interpolated position within one cycle

V_b and V_a are the two signals as indicated in Figure 2.

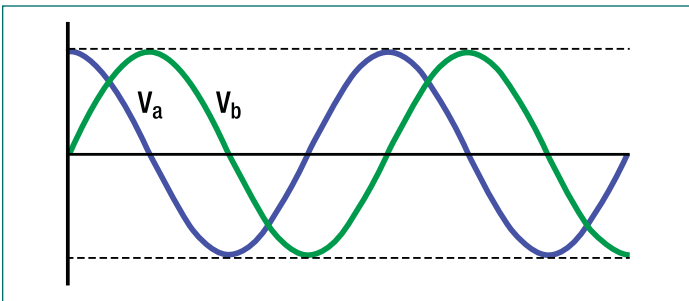


Figure 2: Sinusoidal Encoder Signals

Setting up the Encoder

Sinusoidal encoder interpolation is selected using the AF command:

AFm

- where m=0 uses the default quadrature encoder
- m=5 to 12 indicates that the sinusoidal encoder input is to be used with 2^m interpolation counts per encoder cycle

For example, if the encoder cycle is 40 microns, AF10 results in $2^{10}=1024$ counts per cycle, or a resolution of 39 nanometers per count.

Once an axis is controlled using a sinusoidal encoder, the maximum allowable speed and acceleration settings are increased to 50 million counts per second, and 10^9 counts/s² respectively. This applies to the commands AC, DC, SP, and JG of the axis.

Also, if that axis is controlled in a coordinated move with the VM or LM mode, the parameters of the coordinated move, VA, VD or VS are also increased to the expanded values. However, it is the responsibility of the user to ensure that the speeds on the other axes involved in the coordinated move (if not in sinusoidal encoder mode) remain within the 12 million counts/s limit.

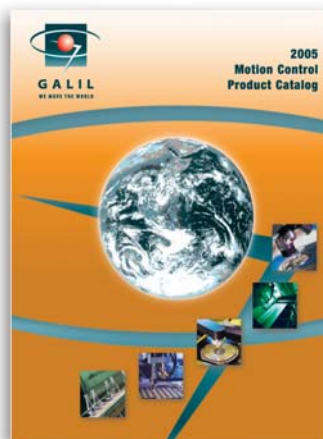
For more information about the DB-28104 Sinusoidal Encoder Interpolation Board please call Galil at 800-377-6329 or go to http://www.galilmc.com/products/accessories/21x3_options.html

Galil Offers Newly Updated 2005 Product Catalog

Galil's product catalog has been updated for 2005 with comprehensive technical specifications and pricing on all their motion controllers and drives. Available now at no cost, simply place your request at 800-377-6329 and your copy will arrive in the mail. Or, go to <http://www.galilmc.com/products/catalog.html> to order a hard copy or download a digital version.

The 96-page catalog features Galil's popular DMC-18xx PCI bus controllers and DMC-21x3 Ethernet motion controllers. Details are also provided on Galil's acclaimed DMC-21x3 Controller n' Drive series which combines a high-performance Ethernet motion controller with a multi-axis drive for stepper or servo motors. The drive attaches directly to the controller without the need for additional wiring or cables, providing a very cost-effective solution that eliminates wiring headaches.

Also covered in the 2005 catalog is Galil's newest Ethernet motion



controller, the CDS-3310. It combines a single-axis motion controller and 500W drive in a compact, metal package. As a result, it can be used as a stand-alone controller for single-axis applications or connected in a distributed network for multi-axis applications.

A very popular section of the catalog is Galil's technical tutorial about motion control. It provides many programming examples for various modes of motion, including point-to-point positioning, jogging, linear and circular interpolation, contouring and electronic gearing. Additionally, the catalog gives details on Galil's WSDK servo

tuning software for "one-button" PID tuning and ActiveX Tool kit for developing operator interfaces for Galil controllers.

Get your free 2005 Galil catalog today by calling 800-377-6329 or visiting <http://www.galilmc.com/products/catalog.html>.

NEW Interconnect Solutions for Galil Controllers

Galil has recently expanded its family of mating hardware designed to connect to Galil controllers. The new additions include:

ICM-3300 Interconnect Module: Attaches directly to the newly released CDS-3310 single-axis controller/drive, and provides optical isolation of I/O and screw terminals for easy connection of external hardware.

DB-28104 Sine/Cosine Daughter Board: Attaches to most Galil controllers using 50-pin header. Accepts sine/cosine encoder signals and interpolates into high resolution position data.

CB-1500 Legacy-to-Optima Converter Boards: Provides an interconnect solution for upgrading Legacy series controllers (which use a 60-pin ribbon cable) to an Optima controller (which uses a 100-pin SCSI cable) or DMC-21x3 controller (which uses a 96-pin connector) without having to rework existing wiring. The ribbon cables from the Legacy series plug directly either into the CB-1500-96, which then provides a 96-pin connector for interface to the DMC-21x3, or into the CB-1500-100, which then provides a 100-pin SCSI connector for interface to an Optima controller.

ICB-99000 Interconnect Converter Board: Provides interconnectivity between most Galil DMC-21x3 amplifier modules and controllers. Galil's DMC-21x3 amplifiers, such as the SDM-20240, AMP-20341 and AMP-20440, plug directly into the 96-pin DIN connector on the ICB-99000. The ICB then connects to a Galil controller through one of three connectors: 100-pin SCSI, two 50-pin male-keyed IDC connectors or a 37-pin D Sub connector. The ICB-99000 is available with or without a DC-to-DC converter.

Interconnect Options for DMC-21x3 Ethernet Motion Controllers:

- **ICM-20100** 4-axis Interconnect with D-type connectors for interface to external drives
- **ICM-20105** 4-axis Interconnect with D-type connectors for interface to external drives. Also includes optical isolation for I/O.
- **SDM-20240** Interconnect with four full/half step drives for stepper motors
- **SDM-206x0** Interconnect with two or four microstep drives for stepper motors
- **AMP-20341** Interconnect with four 20W servo drives
- **AMP-204x0** Interconnect with two or four 200W servo drives
- **AMP-205x0** Interconnect with two or four 500W drives for brushless or brush servos
- **DB-28040** Daughter Board for additional 40 digital I/O plus 8 analog inputs
- **DB-28104** Daughter Board for Sine/Cosine encoder signals. Interpolates into high resolution position data.



Galil's Roadmap for Complying with European Community Directives

The European Community has issued two directives that address the growing concern about possible environmental contamination due to discarded electronic equipment. Galil has responded as follows:

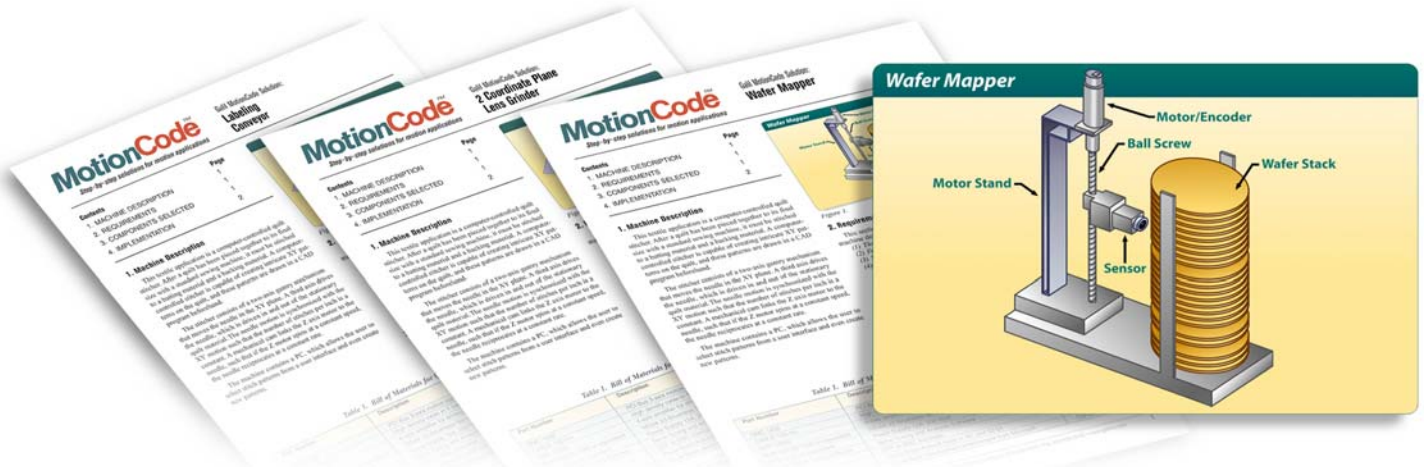
Beginning in July 2005, the first directive (WEEE) will require the recycling of electronic equipment. As a result, Galil will accept discarded Galil products from our European customers, and then recycle them at a local Fortune 500 company's facility.

The second directive (RoHS) requires the elimination of certain

materials (mainly lead) in the manufacture of electronic equipment. This takes effect July 2006, and Galil has instituted a plan for bringing their products into compliance. Beginning in the 4th quarter of 2005, Galil will phase in compliant boards and will have the program complete by the set deadline. These changes will not impact the performance of the products in any way and should not require any action by the user.

Please contact Galil at **800-377-6329** with any questions regarding their plan for compliance with the WEEE and RoHS directives.

Galil Adds Three New *MotionCode*™ Solutions To Its Library



Recently, Galil introduced MotionCode as a free on-line tool to help users tackle motion applications. The original library was comprised of six MotionCode Solutions, and Galil is now adding three new MotionCode examples to its library:

1. *Product label application to a flat surface with ramped gearing*
2. *Lens grinding which requires complex contouring on multiple coordinate planes*
3. *Pick and place wafer-handling robot using multiple Ethernet controllers*

Every MotionCode example shows how to implement a Galil controller for a specific motion type and provides:

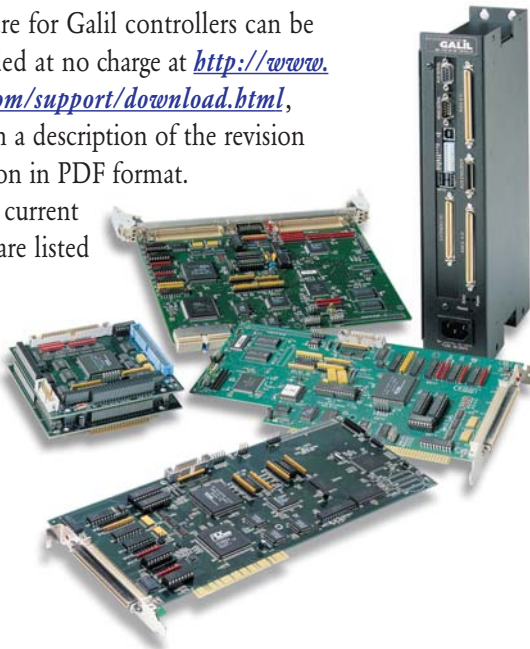
- *A detailed description of the motion problem*
- *Required components*
- *Motion programs*
- *Actual downloadable code.*

View the complete library of MotionCode solutions at:
<http://www.galilmc.com/support/motioncode/index.html>

Download The Latest Firmware For Galil Controllers

Firmware for Galil controllers can be downloaded at no charge at <http://www.galilmc.com/support/download.html>, along with a description of the revision information in PDF format.

The most current revisions are listed at right.



Controller Series	Current Revision
DMC-12xx	Rev 1.0o
DMC-14x5	Rev 1.0h
DMC-16xx	Rev 1.0o
DMC-17xx	Rev 2.2o*
DMC-18x2	Rev 1.0o
DMC-18x0	Rev 2.0o*
DMC-2xx0	Rev 1.0n
DMC-21x2/x3	Rev 1.0n
DMC-31x2/x3	Rev 1.0d
DMC-34x5	Rev 1.0c
IOC-7007	Rev 1.0b
CDS-3310	Rev 1.0

*Current firmware for boards manufactured after April 2004. Consult factory to upgrade pre-April 04 boards to Rev. 2.2o.

NEW Galil .NET API Aids Development of Windows-based .NET Applications

Galil now offers their newly created .NET Application Program Interface (API) designed to provide a set of classes that aid in the development of Windows®-based .NET software applications. Additionally, this API helps programmers by providing the interface they need to communicate to Galil controllers from a .NET environment. .NET API benefits include:

- **.NET compliant.** Data types/structures implemented take advantage of .NET programming environment. All of the core functions needed for communicating with Galil controllers have been ported to the .NET development platform
- **Ease of programming.** Online help (F1) is available for quick access to the help files and “Intellisense” auto-completion of functions.

- **Improved error handling.** Exception-based error handling that simplifies error checking.

The Galil namespace contains classes that define values and reference types used to communicate with Galil motion controllers from a .NET project. Programmers who are familiar with the Galil 'C' API (DMC32.dll) should also find this .NET API to be familiar. The list of classes in the Galil namespace is shown in *Table 1*.

With the .NET API, software developers now have the building blocks necessary to write programs in a common .NET programming environment. A sample VB.NET program to communicate to the controller is shown in *Table 2*. Contact Galil for other VB.NET and C# examples.

Table 1: .NET Classes

DMCAPI	The DMCAPI class is the core of the Galil namespace and supports all communication with Galil controllers.
DMCArray	The DMCArray class allows the programmer to more easily utilize arrays on the motion controller.
DMCDR	The Data Record class represents the data record that most Galil Motion Controllers can produce. The data record is received from the controller in binary form and used to fill in the members of this class for easy access to the information.
DMCException	An exception class derived from System.Exception that adds Galil specific information.
DMCGalilRegistry	The DMCGalilRegistry class supports the use of the Galil Registry. The Galil Registry is a series of keys within the Windows registry that is used to store a controller's communication configuration. When a communication handle is opened to a controller using the DMCAPI class, the information stored in the Galil Registry is used to configure the communication handle.

Table 2: Sample VB NET Program

```
Imports Galil                                     'use Galil namespace

Public Class Form1
    Inherits System.Windows.Forms.Form
    Dim Controller As DMCAPI                       'declare controller object

    Private Sub Form1_Load()
        Controller = New DMCAPI                   'allocate memory for controller object
        Controller.apiOpen(1, System.IntPtr.Zero) 'open communications

        Controller.sCommand("SHX;PRX=10000;BGX")  'Send Position Relative move command
        Controller.apiWaitForMotionComplete("X", True) 'Wait for motion to complete
        TextBox1.Text = Controller.sCmdTrim("TPX") 'Display X axis Position in TextBox1
    End Sub

    Private Sub Form1_Closed()
        Controller.apiClose()                     'close communication
    End Sub
```

Galil. We Move the World.

With over 350,000 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-22x0. Ethernet/RS232, 1-8 axes

DMC-21x2/x3. Ethernet/RS232, 1-8 axes

CDS-3310. Ethernet/RS232, 1 axis controller and servo drive unit

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

Plug-In, Multi-axis Drives

AMP-20341. 4 axis, 20W servo drives

AMP-204x0. 2 & 4 axis, 200W servo drives

AMP-205x0. 2 & 4 axis, 500W servo drives

SDM-20240. 4 axis, full/half stepper drives

SDM-206x0. 2 & 4 axis, microstep drives

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. Request a free catalog at <http://www.galilmc.com/products/catalog.html>.

Rely on Galil for Unmatched Support and Service

With every Galil controller you own, you also get the industry's most skilled team of motion specialists as well as an impressive array of online support tools.

Galil's motion specialists have over 100 man-years of experience, and they stand ready to specifically address your application. You can reach them today at 800-377-6329.

Galil's free online support tools include:

FREE	ONLINE SUPPORT TOOLS
	Application bulletins, white papers and industry articles http://www.galilmc.com/literature/technotes.html
	Library of over 20 tutorials about servo tuning, motion programming, motor and drive technology and more http://www.galilmc.com/training/webconf.html
	MotionCode™ Toolkit, a step-by-step guide for solving a range of motion applications. Includes actual motion programs and downloadable code http://www.galilmc.com/support/motioncode/index.html
	Interactive bulletin board with knowledge base for fast answers to your questions http://www.galilmc.com/cgi-bin/ubb/ultimatebb.cgi
	Extensive motion controller and drive product catalog with specs and prices http://www.galilmc.com/products/catalog.html



"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"