

Introducing the *Next* Generation in Motion Control: *The Accelera Series*

Galil is proud to launch their new generation of motion controllers, the Accelera Series, which incorporates a powerful, 32-bit Risc-based microcomputer that delivers higher speed performance and processing power than previous generation controllers. In fact, speed has been improved so that these Accelera controllers can accept encoder inputs up to 22 MHz, servo update rates as low as 24 microseconds per axis, and command execution speeds as low as 40 microseconds. This is Galil's fifth generation of motion controllers and crowns a 20-year legacy of innovation.

The first product to be released as part of the Accelera series is the new DMC-18x6 PCI bus motion controller.

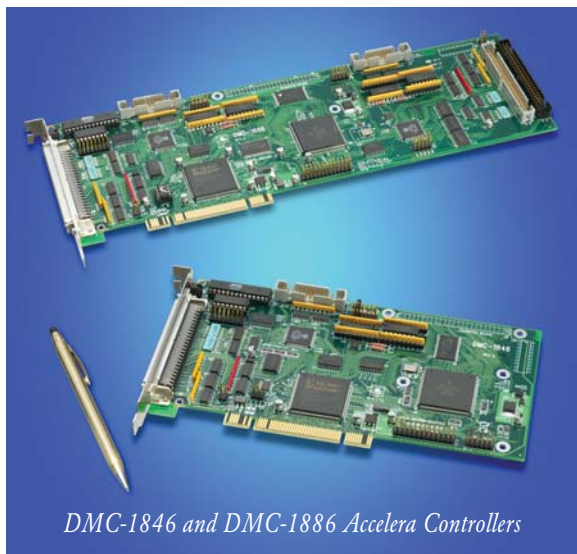
While it offers performance enhancements over prior generation PCI controllers, the programming language and 100-pin SCSI connector remains virtually the same, making conversion to the DMC-18x6 quick and easy. Also, Galil has priced the DMC-18x6 the same as the prior generation, DMC-18x0 series, in order to keep its commitment to cost-effective motion control for OEMS.

■ Risc-based Processing

At the heart of the DMC-18x6 is a powerful, Risc-based, clock multiplying processor with DSP functions. This allows for fast command processing and servo loop update times that are significantly better than prior generation controllers. For example, the DMC-1886 8-axis controller has an update rate as low as 24 microseconds per axis. Having fast servo update rates is important for applications that use low-inertia, high bandwidth motors.

The DMC-18x6 also provides command execution speeds that are ten times faster than the prior generation with processing times as low as 40 microseconds per command. Fast command processing is important in many applications that require very tight synchronization of multiple motion and I/O tasks.

Speed is further increased with the encoder input frequency of these new generation controllers. The DMC-18x6 accepts inputs from quadrature encoders up to 22 MHz. High frequency inputs are often crucial for applications in which very high-resolution feedback sensors are used. Also, the frequency of the stepper pulse output is increased by a factor of two with the maximum pulse rate of 6 MHz.



DMC-1846 and DMC-1886 Accelera Controllers

Galil's DMC-18x6 is available in one-through eight-axis formats and, like all Galil controllers, the user need only purchase the number of axes required. Each axis is user-configurable for stepper or servomotor operation, enabling the user to easily mix-and-match motor types in an application.

Standard servo loop features include advanced PID compensation, velocity feedforward, acceleration feedforward, integrator limits, notch filter, low-pass filter, and backlash compensation.

The DMC-18x6 provides expanded memory for variables, arrays and storing application programs. It also allows multi-tasking for simultaneously running up to eight programs and fast I/O processing

for precisely synchronizing motion with external events. Modes of motion include point-to-point positioning, position tracking, jogging, linear and circular interpolation, contouring, electronic gearing and ECAM. Advanced commands for coordinated motion include ellipse scaling, slow-down around corners, infinite segment feed and feedrate override.

■ Plenty of I/O

The new DMC-18x6 controller provides optically isolated inputs for enhanced noise immunity. Standard inputs for each axis include a forward limit, reverse limit and homing input. The controller also features 8 uncommitted digital inputs and 8 uncommitted digital outputs for the 1- through 4-axis models, and 24 inputs and 16 outputs for the 5- through 8-axis models. Expansion for 64 more I/O is available with the optional DB-14064 board. In addition, the DMC-18x6 has 8 uncommitted analog inputs that allow the controller to interface with analog sensors such as joysticks and temperature sensors. Inputs from two separate encoders are available for each servo axis.

For connection of signals, the DMC-18x6 uses a 100-pin SCSI cable, with one 100-pin cable required for each set of 4 axes. Galil's ICM-2900 interconnect module breaks out the cable into screw terminals to allow for convenient connection of external sensors and drives. As needed, Galil's AMP-19540 4-axis servo drive is available for driving brush or brushless motors up to 500 Watts.

Please call Galil at 800-377-6329 or go to <http://www.galilmc.com/products/accelera/dmc18x6.html> for more information about the powerful, new DMC-18x6 Accelera Series controller.

High-Speed Command Processing with DMC-18x6 *Accelera* Controller – Semiconductor Metrology Application

By Todd Shearer, Applications Engineer

1. Application Description

During semiconductor wafer fabrication, the wafer goes through the critical processes of micro-lithography, implant, deposition, and etch. At various times during these processes, the wafer is removed and brought to a special station for measurement, a process known as metrology. Specialized metrology equipment is then used to verify the thickness, alignment and integrity of the various coatings and films found on a wafer. Each of these inspections may take hundreds to thousands of measurements in order to ensure quality. Due to the high number of measurements taken in the processes, maintaining high throughput is extremely important.

Because of the need for high throughput, Galil high performance controllers have been used for several years in metrology equipment. As the throughput of these machines has increased, Galil’s motion controllers have also been required to deliver increased speed and accuracy. In addition, with the PC responsible for the very complex math required for calculating and identifying defects, more and more control routines are being offloaded to the motion controller.

The application discussed in this article details the use of a Galil PCI-bus controller on a 3-axis metrology instrument.

Galil’s new DMC-18x6 Accelera controller will be used to increase the throughput of the aforementioned metrology instrument. The original machine was developed around the DMC-18x0 Optima series and, along with mechanics, was a limiting factor in the machine throughput. The DMC-18x6 now provides increased software processing power, as well as faster servo loop update rates, when compared with the DMC-18x0 Optima series controller.

2. Specifications

There are three critical axes on this metrology instrument: two axes (XY) of linear motors with 1.0µm resolution are used to control the position of the measurement head while a single Z axis linear motor with 0.1µm resolution is used to raise/lower the actual measurement sensor.

Multiple measurements are taken in a raster pattern across the

wafer surface. These measurement points are sent from the PC to the controller based on the specific dies that are found on a given wafer. At each measurement point, XY motion must be settled to within +/- 3.0µm, with the Z-axis settled to +/- 0.3µm. Any movement outside of this error band disqualifies the measurement being taken.

The controller application program (call Galil for complete code) is structured to “handshake” with a PC program. During this, a measurement position is sent from the PC to the controller using an array command (QD), which includes target positions, profile speeds and time increments. The controller then performs the specified motion, verifies settling on all three axes, begins the measurement process, and uploads an array to the PC with position and analog data. This constitutes one complete measurement cycle, and is repeated for each measurement on the wafer. In addition, other threads are operating to monitor for I/O processes as well as error conditions.

3. System Performance

Due to the high number of commands in the controller application program, throughput is affected by how quickly the program lines are processed. The new DMC-18x6 Accelera series controller offers a speed advantage by processing each software command in about 40 microseconds, which is 10 times faster than the DMC-18x0 Optima controller.

Shown in Figure One are numbers for this metrology application for typical moves. The move time is the theoretical time for the XYZ move to complete. This number is fixed based on the motion parameters. Total measurement time includes move time, settle time, and software measurement time.

4. Application Summary

As seen from the measurement times, the DMC-18x6 Accelera provides an immediate increase in throughput for this machine. Also, given that a wafer may have thousands of these measurements taken, there is a significant time savings with faster command processing.

Figure 1.

	X Move distance (µm)	Move Time (msec)	Total measurement time (msec)	Time/1000 measurements
DMC-18x0	1000	32	92	92 seconds
	100	10	82	82 seconds
	25	5	78	78 seconds
DMC-18x6	1000	32	42	42 seconds
	100	10	30	30 seconds
	25	5	22	22 seconds

Galil Controller Steers Team Mojavaton's Autonomous Ground Vehicle In DARPA Challenge



The sci-fi vision of robotic, unmanned vehicles is more reality than fantasy. There are remote-controlled mini subs exploring the deep seas, Mars rovers transmitting stunning images, and pilot-less, flying drones gathering surveillance in hostile territories.

While incredibly advanced, this technology remains remote controlled by a human source. Now, science wants machines that can operate and think entirely on their own.

As a result, the US Department of Defense sponsors the DARPA (Defense Advanced Research Projects Agency) Grand Challenge, which encourages the development of autonomous ground based vehicles that can eventually replace manned vehicles used in dangerous missions. A \$2 million prize is awarded to the winning team whose vehicle travels the fastest in less than ten hours across 175 miles of treacherous roads and trails.

Using Congressional authority, DARPA conducts vigorous qualifying rounds to get the large entry list of 136 applicants down to forty finalists. "It takes ingenuity and perseverance to build a vehicle that can win the Grand Challenge prize," says Tony Tether, DARPA Director.

Rising to the challenge is Jim Crittenden, who formed Team Mojavaton to convert and enter a Nissan Xterra. The team is experienced in custom machine building, design, vision systems, control systems, electronics, programming and project management.

"Since this event will be very hard on every vehicle, we placed a high premium on reliability and survivability," said Crittenden. "Our autonomous systems won't be able to avoid every little rock

and rut, so we know that the vehicle will have to take a beating. We'll be happy if we can just avoid the major, race ending obstacles like the tank traps and sheer drop-offs."

To help control the critical steering and throttle functions, the team turned to Galil's DMC-1416 single axis controller and drive combination. It connects to an Ethernet network, and is designed to respond accordingly to the approximately 2,500 GPS waypoints that are loaded into the program of the vehicle's computer system. These waypoints define the course for the vehicle to follow.

In addition to being able to follow the waypoints, Crittenden says, "Each vehicle must have the ability to 'see' the terrain ahead and identify the various obstacles that are a part of off-road driving." To accomplish this, the vehicle uses two machine vision camera systems and two laser range finders.

Team Mojavaton was drawn to Galil because of its well-established record for controllers that deliver flawless precision, accuracy and unending repeatability. "Galil's controller and drive was very affordable and easy to program. We especially loved the position tracking mode, which is critically important because it has to make about ten decisions per second about which way to go in order to keep the vehicle steering in the right direction. Position changes are truly made on the fly, and the Galil has performed fabulously—bullet proof," adds Crittenden.

Recently, Team Mojavaton received the exciting news that their entry was chosen to be among the 40 participants to participate in the semifinals scheduled to commence on September 27, 2005. Information about the DARPA Grand Challenge can be found at <http://www.darpa.mil/grandchallenge/>.



DMC-1416

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-18x6. PCI, 1-8 axes. *Accelera*

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

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:

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✓	Over 20 tutorials about servo tuning, motion programming, & motors and drives http://www.galilmc.com/training/webconf.html
✓	MotionCode™ Toolkit, step-by-step solutions with downloadable code http://www.galilmc.com/support/motioncode/index.html
✓	MotorSizer™ Tool for quick sizing of stepper and servo motion systems http://www.galilmc.com/support/motorsizer/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"