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DCX 300 Series Controllers

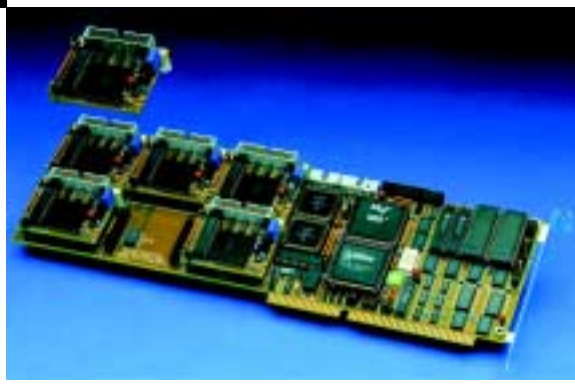
An Introductory Guide to DCX 300 Series Motion Control Cards...



The DCX 300 Series combines the latest in state-of-the art motion control technology with the proven and popular modular DCX control architecture first pioneered by PMC over a decade ago. Powerful features include:

- Advanced RISC, DSP & FPGA technology
- One DSP dedicated to EACH AXIS, guaranteeing reliable multi-axis performance & determinism
- Linear & circular interpolation, gearing, contouring, spline & continuous path motion
- Trapezoidal, parabolic, and S-curve velocity profiles for smooth, jerk-free motion
- On-board sinusoidal commutation for precise control of AC brushless servo motors
- 10 million encoder count/sec each axis for high-speed, high-resolution servo control
- 2.0 MHz pulse output for high-speed micro-stepping
- 8 KHz servo loop update rate per axis
- On-the-fly parameter and trajectory modification
- Open and closed-loop stepper control
- On-board multi-tasking of up to 10 independent user programs
- Dual-ported memory for fast bus communication
- Comprehensive software API for the ultimate in high-level programming flexibility
- Full support for Windows 95/98/NT/2000

- ***A powerful board-level motion controller designed for the most demanding OEM machine control applications***
- ***Multi-axis synchronized control of any combination of servo and stepper motors***
- ***Available for PC ISA-bus, VME-bus or embedded operation***

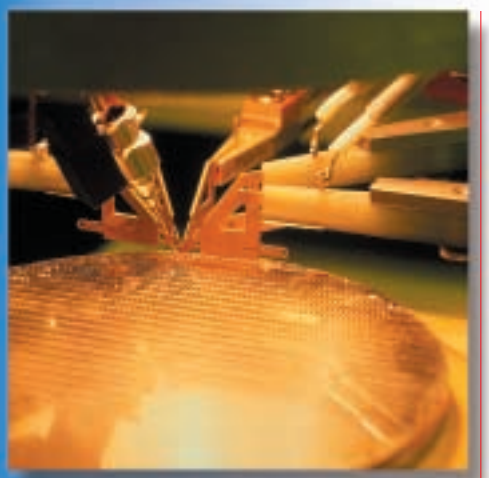


PMC Motion Control
Precision MicroControl Corp.

For Robotics & Machine Automation

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Introduction to DCX Motion Control



Semiconductor Wafer Probing

Precision MicroControl's DCX 300 Series motion control cards offer the latest in state-of-the-art motion controllers. PMC is the only company to offer board-level, plug and play, modular architecture. The benefits of this unique architecture include:

Reduced Development Time: The DCX 300 Series can be configured (or reconfigured) in minutes with simple, off-the-shelf components to suit most applications.

Reduced Maintenance Time and Costs on Installed Systems: The plug & play modular architecture facilitates troubleshooting in case of failure. Only the failed module requires replacement, not the entire card.

Reduced Inventory Investment: There is no need to stock complete fixed architecture controllers, only the less expensive function modules.

Cost Effective: You only pay for the number of control axes required by your application. Simply add or subtract control axes without having to return the card to the factory.

Real-Time, Deterministic Performance: Unlike fixed architecture motion control cards, the control axes on the DCX 300 Series do not share a common microprocessor. A 40 MHz DSP is dedicated to EACH AXIS, therefore there is no degradation in the card's overall performance when more than one axis is being controlled.

Each DCX 300 Series motion control card consists of an intelligent motherboard populated with any mix or match of one to six intelligent 'plug-in' function modules. As many as 16 motherboard cards can simultaneously control as many as 96 axes. Function modules are available for Servo and Stepper control, Digital I/O, Analog I/O, and RS-232/422 or IEEE-488 communications.

How to configure a DCX 300 Series Motion Controller:

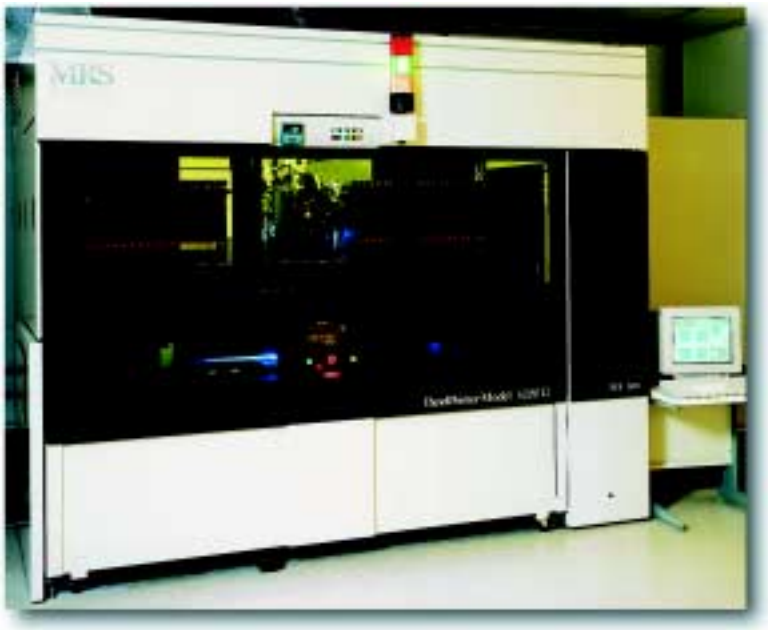
1. Select DCX Motion Control Motherboard (maximum 16 per system):
   - **PC/ISA based** — **DCX-AT300**
   - **VME based** — **DCX-VM300**
   - **Stand-alone** — **DCX-AT300 or DCX-VM300**

2. Select DCX "plug-in" modules (maximum of six per motherboard):

   Motion modules (Note: Motion Modules include all axis I/O)
   - **Servo (+/- 10 volt)** — **DCX-MC300** Servo Control Module (analog control signal)
   - **Servo (sine)** — **DCX-MC320** Sine-Commutating AC Brushless-Servo Control Module
   - **Stepper** — **DCX-MC360** Stepper Control Module

   I/O modules (Note: Each DCX 300 Series Motherboard already includes I/O on-board)
   - **Digital I/O** — **DCX-MC400** 16 channels (in addition to 16 on motherboard)
   - **Analog I/O** — **DCX-MC500** 4 in + 4 out (in addition to 4 on motherboard)

   Communication interface modules (for stand-alone operation)
   - **RS-232** — **DCX-MF300**
   - **IEEE-488** — **DCX-MF310**



Flat-Panel Microlithography

DCX 300 Series Features

Powerful & Flexible DSP / FPGA architecture

The DCX 300 is the only multi-axis controller with a 40 MHz DSP dedicated to ***each axis*** - guaranteeing real-time, deterministic performance regardless of the number of axes controlled. Additionally, high-capacity Field Programmable Gate Arrays (FPGA's) on each axis allow full customization of the controller's hardware interface. Custom functions implemented in hardware will run many times faster than if implemented in software as most competing systems must do. PMC can readily customize a DCX 300 Series controller to provide powerful new functionality for the unique requirements of the most demanding OEM applications.

C-Programmable: Powerful High-Level Programming Options

For experienced programmers, extensive interface libraries are supplied with example programs and source-code for C, C++, Delphi, LabVIEW, and Visual Basic. Supported operating systems include DOS, Windows 95/98 and Windows NT/2000. For more information about PMC software, a complete overview is provided in PMC brochure titled "Programming & Integration" and an in-depth reference is provided in the DCX AT300 product manual and online help files. For an at-a-glance list of available API functions, ask for the latest version of our "MCAPI Programming Quick Reference Card".

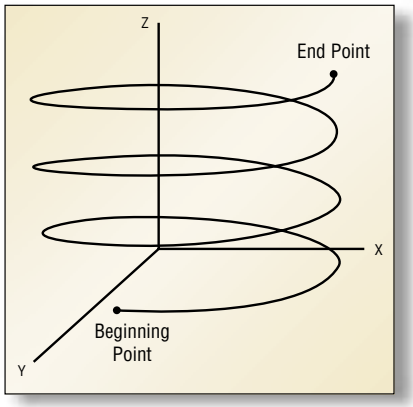


Figure 1: 3-D Motion

Easy-to-Use Command Language

High-level programming ability is not a pre-requisite for programming DCX 300 series motion control cards. They can also be programmed using simple, intuitive two letter commands, which form the basis of our popular Motion Control Command Language (MCCL). Even the most complex motion control routines can be executed using this command language, which allows conditional branching (If...Then...), callable macros, and other elements of structured programming. MCCL routines can be stored to on-board non-volatile memory. Using the controller's multi-tasking capability, up to 10 MCCL routines can run concurrently, freeing the host PC for other tasks.

Motion Integrator™ with Interactive Servo Tuning

Motion Integrator™ is an extensive suite of graphical Windows tools designed to speed the task of installing and configuring PMC controllers. In addition to stepping users through the installation and integration process, Motion Integrator includes a new high-resolution graphical utility for tuning the PID filter characteristics of a servo. This easy-to-use utility allows users to match the servo parameters to the requirements of a particular motor/actuator/load configuration. Servo parameters can be saved on a disk for later use or for incorporation into user programs. *(See Figures 3 and 4)*

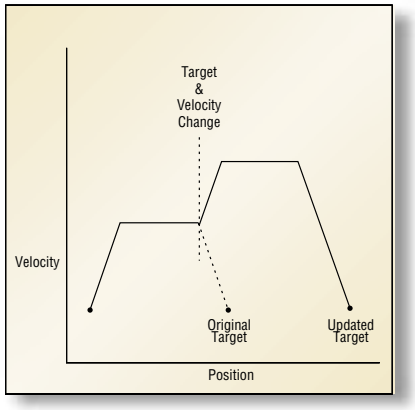


Figure 2: On-the-fly Parameter & Target Changes

Available for Stand-alone or Embedded Operation

For deployment outside of a host PC or requiring very fast system initialization, the DCX 300 Series controllers provide on-board non-volatile Flash Memory devices to store up to 767 user-defined software routines (macros), which can execute automatically at controller boot-up with no host intervention.

Combine Servo & Stepper Control

The DCX 300 Series card is easy to configure for the control of any combination of servo and step motors. For stepper control, the MC 360 Stepper Module provides step/direction or a CW/CCW signal. For servo control, the MC 300 Servo Control Module provides a standard +/- 10 VDC analog control signal for use with most servo amplifiers or drives, and the MC320 Sine Drive Servo Module provides a sinusoidal commutation output for ultra-smooth control of AC brushless sine motors.

Sinusoidal Commutation of AC Brushless Motors

The DCX 300 Series generates two and three phase sinusoidal commutation signals to control AC brushless sine motors with superior accuracy and smoothness. Each commutating axis has two DAC chips on-board - eliminating the need to use two control axes per motor or to add external commutating hardware. This option works with simple 'power block' type servo amplifiers to not only provide extremely accurate motor control, but also to reduce system cost, since it eliminates the need for expensive commutating servo amplifiers - a big plus for multi-axis OEM applications.

Multi-Tasking

DCX 300 Series motion control cards provide true multi-tasking command execution. In addition to simultaneously controlling more than one axis of motion, these cards allow the user to perform as many as ten independent background tasks including: PLC interfacing, homing sequences, process control, I/O scanning, position capture, conditional execution and branching, etc. CPU time is divided evenly among all executing tasks.

High-Speed Communication

With Dual Ported Memory, the DCX 300 Series provides the option of communicating with the host computer via either a High-Speed Binary interface or an easy-to-use ASCII Interface. For applications that require maximum command throughput, the High-Speed DCX Binary Interface allows communication directly with the motion control card through a memory-mapped command buffer, thus bypassing the ASCII command interpreter on the card. This avoids the command interpreter ASCII I/O Mailbox communication bottleneck associated with many other motion control cards. The Binary Interface also allows the host computer to quickly move on to other tasks.

S-Curve, Parabolic and Trapezoidal Velocity Profiles

DCX 300 Series motion controllers support various types of velocity control including: Trapezoidal, Parabolic and S-curve. This provides the ultimate in motion control flexibility. Trapezoidal velocity profiles permit the shortest cycle times for point-to-point motion, but can produce undesirable mechanical jerks.

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Parabolic velocity profiles reduce mechanical jerks but require a longer cycle time. S-curve velocity profiles produce ultra-smooth, jerk-free motion but require the longest cycle time.

3-D Motion: Linear Interpolation, Circular Contouring and Helical Motion

Many demanding applications require multi-axis contouring. The DCX 300 can perform linear interpolation and circular contouring simultaneously on one to six axes without the intervention of a host computer. For example: axes 1 & 2 can execute a linear traverse, while 3 & 4 trace a clockwise circle and 5 & 6 trace a counterclockwise circle. Programmable parameters include Vector Feed Rate (vector velocity), Vector Acceleration, and Vector Deceleration. All of these parameters can be changed on-the-fly.

Electronic Gearing, Master/Slave

As many as six axes can be electronically geared (slaved) to a master axis which may or may not be a motor controlled by the DCX card. Each slaved axis will follow the master at its own specified gear ratio. More than one axis can be slaved to the same (master) axis, and there can be more than one master axis on the same card. All axes not geared or slaved to a master can be commanded to move independently.

2 MHZ Pulse Output for High-Speed Micro-Stepping

Micro-stepping drivers, state-of-the-art for stepper motor applications, are used to increase accuracy and eliminate resonances. For any motion control system to take advantage of this micro-stepping technology, it is not only necessary to be able to output control pulses at a very high frequency, but also with high velocity resolution. To support micro-stepping, DCX 300 Series controllers provide three software programmable output dynamic ranges between 15 steps/second and 2 million steps/second (per axis) on one to six axes. Each stepper axis also has its own encoder, index, home, joystick and limit switch inputs.

Superior Stepper Accuracy

The DCX 300 Series controllers can ensure the most accurate and repeatable stepper positioning possible by 'closing the loop' with position feedback from an encoder. Step motors are typically controlled 'open-loop' without position feedback, so a torque demand that exceeds the motor's stall torque can cause a stall (missed steps) and inaccurate positioning. Selecting a motor with greater torque margin is one way to lessen the chances of stalling, but this adds to the motor's size, cost, and heat dissipation. The DCX 300 closed-loop stepper option compensates on-the-fly for friction and load torque variations to ensure that motion remains consistent, accurate and repeatable.

On-the-fly Parameter and Target Changes

The DCX 300 Series permits the changing of motion parameters and the target position on-the-fly. Parameters that can be changed include: Velocity (feed rate), acceleration, deceleration, and PID-FF filter coefficients. Any motion control card without this capability must suspend motion control before any changes can be made.

High-Speed Position Capture Input & Position Compare Output

For applications requiring ultra-precise synchronization of motion controller functions to external events - such as in high-speed web registration, fluid dispensing or optical scanning applications, the DCX 300 Series provides dedicated high-speed position capture (input) and position compare (output) with latency times of less than 1 microsecond. Additionally, a rich set of control functions offers unprecedented flexibility in configuring these features.

Easy Firmware Upgrades

PMC software includes a convenient Windows-based Flash Wizard, which allows quick upgrades of the motion controller firmware simply by running this easy-to-use program. The latest version of the DCX 300 Series firmware is always available for download in the Support section of PMC's web site, at www.pmccorp.com.



PCB Routing

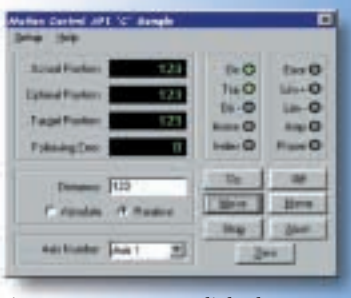


Figure 3: A system setup dialog box

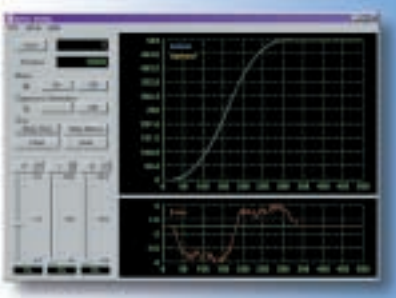


Figure 4: Interactive Servo Tuning with error plotting

Listed here are just a few of the significant features of the DCX 300 Series Controllers. A comprehensive description of all features is provided in the DCX 300 Series Product Manuals. The complete manuals can be downloaded in Adobe Acrobat™ format from the 'Support' section of the PMC web site at: www.pmccorp.com

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DCX 300 Series Specifications

Processor

- Motherboard: Intel 32-bit RISC processor / 64-bit floating point co-processor
- Axis Modules: Texas Instruments 40 MHz DSP & 10,000 gate FPGA on each axis

Communications

- DCX-AT300: PC-ISA bus with Dual-Ported SRAM
- DCX-VM300: VME bus with Dual-Ported SRAM
- High-speed binary or ASCII communication

Programming

- Programmable using C/C++, Visual Basic or Delphi (Pascal)
- LabVIEW/BridgeVIEW support via the Motion VI Library*
- Native drivers for DOS, Windows 95/98 & Windows NT/2000*
- Motion Integrator™ graphical Windows utilities for tuning, setup, and diagnostics*
- On-board Motion Command Language (MCCL) with multitasking of up to 10 tasks

Motion Capabilities

- 1, 2, 3, 4, 5, or 6 control axes per card
- Servo and/or stepper motor control
- Point-to-point positioning
- Multi-axis synchronized & coordinated motion
- Trapezoidal, parabolic, and S-curve velocity profiles
- Independent acceleration & deceleration
- Linear and circular interpolation
- Linear interpolation of up to 6 axes
- Spline interpolation of up to 6 axes
- Multi-axis contouring
- Electronic gearing
- Position, velocity, torque , gain, and jog control modes
- High-speed position capture input
- High-speed position compare output
- Backlash compensation
- Tangential knife control
- Vector velocity laser control
- Change motion trajectory & parameters on-the-fly
- Custom motion capabilities available upon request

Memory

- 2 Mbytes RAM
- Non-volatile user program memory: 32K (128K optional)
- 256 general purpose user registers

Kinematic Ranges

- Position: 64-bit floating point
- Velocity and acceleration: 64-bit floating point

Servo Control

- ±10V command signal with 16-bit DAC resolution
- Simultaneous update of all axes
- On-board sinusoidal commutation (with DCX-MC320 module)

Servo Filter

- PID with velocity, acceleration and deceleration feed-forward
- Selectable servo loop update rate (2,4, or 8 KHz) up to 6 axes

Stepper Control

- Pulse/direction or CW/CCW stepper control
- 2 MHz maximum step rate each axis (up to 6 axes)
- 50% pulse train duty-cycle at all pulse rates
- Full/half step, full/half current control signals
- Closed-loop control (option)

Position Feedback

- Quadrature incremental encoder with index
- 10 MHz encoder count rate per axis (up to 6 axes)
- Single-ended or differential inputs (A+, A-, B+, B-, I+, I-)
- Auxiliary encoder (A+, A-, B+, B-, I+, I-)
- Digital noise rejection
- 32-bit resolution

Dedicated I/O *(each axis)*

- Axis inputs: (opto-isolated) home, ± limits, amp fault
- Axis outputs: (opto-isolated) amp enable, step direction
- Position capture input (less than 0.5 microsecond latency)
- Position compare output (less than 10 microsecond latency with opto-isolation)

General Purpose I/O

- 16 digital I/O on motherboard, individually software configurable
- Up to 96 additional configurable digital I/O
- 4 analog inputs on motherboard, 8-bit resolution
- Up to 48 additional analog I/O, 12-bit resolution
- On-board analog offset & full scale adjustment

Other Features

- Windows Flash Wizard for quick, power-on firmware updates
- Programmable in user units
- On-board watchdog timer with external or PC-bus reset
- Custom controller features available upon request

Connections

- 26 pin dual-row IDC ribbon header for each axis and I/O module
- 26 pin dual-row IDC ribbon header for on-board digital I/O
- DCX-VM300: Optionally configurable so axis & I/O signals are available on VME P2 connector
- Interface adapter for Opto 22 or Grayhill relay racks
- Optional axis interconnect adapters with individually labeled screw terminals

Environmental & Mechanical

- Operating temperature: 0-55°C (32-131°F)
- Size: 335mm x 107mm (13.2" x 4.2")

** For PC-based systems only*

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Part Numbers/Descriptions

Motherboards

Description	Part Number
1 to 6 Axes PC/ISA-bus motion control motherboard	DCX-AT300
1 to 6 Axes VME-bus motion control motherboard	DCX-VM300
Configurations available for DCX-VM300 (VME) motherboard	
Factory standard, no axis I/O signals available on VME P2 connector	DCX-VM300-10
4 axes I/O signals available on P2 connector rows A and C	DCX-VM300-20
6 axes I/O signals available on P2 connector rows A, B and C	DCX-VM300-30

"Plug-in" Motion and I/O Modules

Description	Part Number
DC Servo Motor Control Module (+/- 10 volt control output)	DCX-MC300
AC Brushless Servo Control Module with dual-DAC (Sine Commutation)	DCX-MC320
Stepper Motor Control Module	DCX-MC360
RS-232 Interface Module	DCX-MF300
IEEE-488 bus Interface Module	DCX-MF310
16 Channel Digital I/O Module	DCX-MC400
12 bit Analog I/O Module	
4 Channel Analog Input and 4 Channel Analog Output	DCX-MC500
4 Channel Analog Input	DCX-MC510
4 Channel Analog Output	DCX-MC520

Accessories

Description	Part Number
Relay Rack Interface: 16 Channel	DCX-BF022
(Plug compatible with Opto 22 and Grayhill)	
Optional Interconnect Boards	
For Servo Axis	DCX-BF300
For Stepper Axis	DCX-BF360
Terminal Block: Panel mount DB25 to 26 screw Terminal Strip	93-030-A
DCX Module Ribbon Cable: For DCX-BF300, DCX-BF360, and DCX-BF022	95-020-A
DCX Module Connector Kit: Crimp Pins (26 PCS.) and Connector Housing	95-050-A
DCX PC Edge Connector: For stand-alone applications	70-105-A

Ordering Information

- Free evaluation: qualified users may evaluate our products free of charge. Please contact an application engineer today to discuss your motion control solution.
- Manuals/Utility Software: one set of manuals and software is included free of charge with first motherboard order.
- Custom engineering: For the OEM and Systems Integrator, we offer custom design and manufacturing services. Our engineering staff are ready to work with you to design a control solution that fits your application and your budget.

FIVE YEAR WARRANTY

PMC – The first to offer you a 5 year warranty: We believe in our products and offer you the most comprehensive endorsement in the industry. We guarantee our products to be free from defects in materials and workmanship for 5 years after purchase.

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- Technical Support ..... (760) 930-0292
- Fax ..... (760) 930-0222
- E-mail
  - Information ..... info@pmccorp.com
  - Sales ..... sales@pmccorp.com
  - Technical .... support@pmccorp.com

Motion Control Integration and Diagnostic Tools

To assist the machine builder, powerful software tools are included with every PMC motion controller. Our Motion Integrator™ suite of setup, tuning and diagnostic programs will help you get your system up and running quickly. See our brochure titled "Programming & Integration" for more details about PMC software.







We continuously develop new software tools. Please consult our factory for the latest available software.

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