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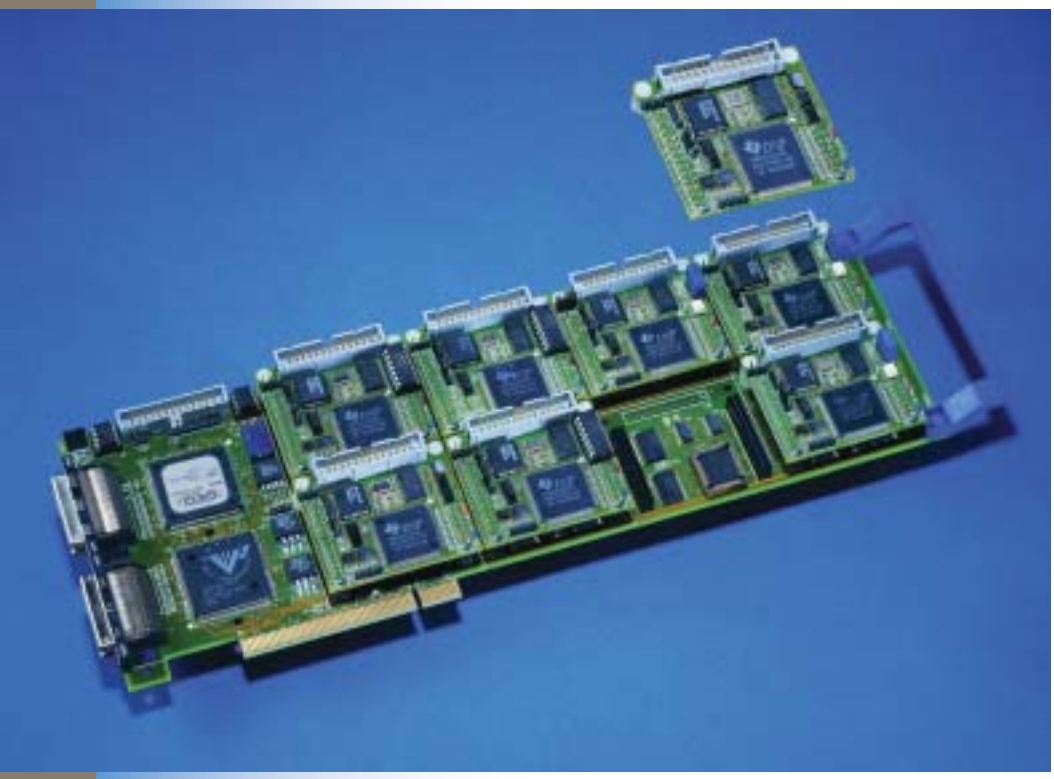
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DCX-PCI300 Motion Controller

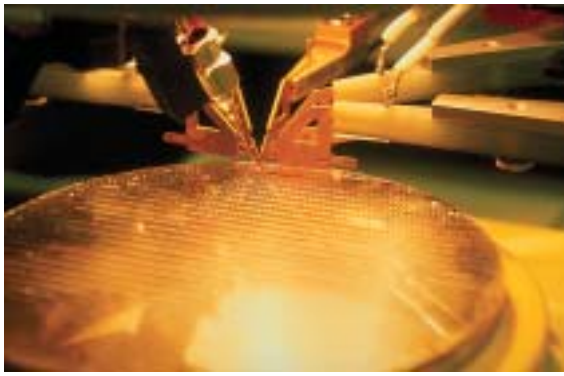
An Introductory Guide to the DCX-PCI300 Motion Control Card…



The DCX-PCI 300 combines state-of-the-art motion control technology with the flexible and field-proven multi-processor architecture first pioneered by PMC over a decade ago. Powerful features include:

- Advanced DSP, RISC & FPGA technology
- From 1 to 16 axes on a single card
- One DSP dedicated to each axis module, guaranteeing reliable & deterministic performance
- 8 KHz servo loop rate each axis (16 axes)
- 5 MHz pulse output for high-speed micro-stepping (16 axes)
- 10 million encoder count/sec each axis for high-speed, high-resolution servo control
- Trapezoidal, parabolic, and S-curve velocity profiles for smooth, jerk-free motion
- On-the-fly parameter and trajectory changes
- On-board sinusoidal commutation for precise control of AC brushless servos
- Open or closed-loop stepper control
- On-board multi-tasking of up to 10 independent user programs
- Very high density connectors (VHDCI) for enhanced robustness and reduced cabling
- Up to 128 general-purpose digital I/O and up to 64 analog I/O
- Fast PCI-bus communication with bus interrupt capability
- Fast on-board command execution
- Fully programmable in C/C++, Visual Basic, Delphi or easy-to-use command language
- Full support for Windows 98/NT/2000/XP

- ***A powerful and cost-effective PCI-bus motion controller for demanding OEM machine control applications***
- ***Synchronized control of up to 16 servo and stepper motors from a single PCI board***
- ***Comprehensive software API for exceptional programming flexibility***



PMC Motion Control
Precision MicroControl Corp. Since 1987

Introduction to DCX Motion Control



Automated Component Placement

Precision MicroControl's DCX-PCI 300 motion control card is designed to provide high-performance and economy to machine builders requiring real-time PC-based motion control. It incorporates our flexible and field-proven parellel multi-processor architecture. The benefits of this unique modular architecture include:

Reliable, Deterministic Performance: Unlike fixed-architecture motion control cards, control modules on the DCX 300 Series PCI card do not share a common processor. In addition to a powerful RISC CPU, a 40 MHz DSP is dedicated to each axis module. This highly parallel multi-processor architecture guarantees robust, predictable performance that does not degrade - no matter how many axes are controlled.

Reduced Development Time: The DCX 300 Series PCI controller can be reconfigured in minutes with simple off-the-shelf function modules to suit almost any application.

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

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

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

Each DCX-PCI 300 motion control card consists of an intelligent motherboard populated with any mix or match of one to eight intelligent "plug-in" function modules to control up to 16 axes from a single card. As many as 16 motherboard cards can simultaneously control as many as 256 axes. Function modules are available for Servo and Stepper control, Digital I/O and Analog I/O.

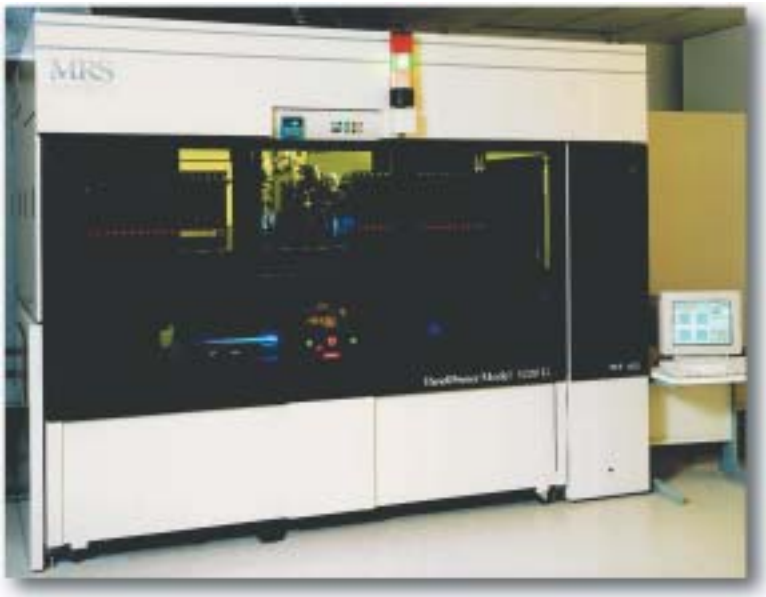
How to configure a DCX 300 Series PCI Motion Controller:

1. Select DCX Motion Control Motherboard (maximum 16 per system):

PCI-bus card	**DCX-PCI 300**

2. Select DCX "plug-in" Modules (maximum of eight per motherboard):

Motion modules	Note: Motherboard already includes 16 digital I/O
Servo (+/- 10 volt)	**DCX-MC300** Servo Control Module (analog control signal)
Servo (Sine Commutation)	**DCX-MC320** Sine-Commutating AC Brushless Servo Control Module
Stepper	**DCX-MC360** Stepper Control Module
Dual Servo	**DCX-MC302** Two Axis Servo Control Module (analog control signal)
Dual Stepper	**DCX-MC362** Two Axis 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 (Note: Motherboard includes16 digital I/O)
Analog I/O	**DCX-MC500** 4 in/4 out channels, 12 bit
Analog I/O	**DCX-MC510** 4 input channels, 12 bit



Flat-Panel Microlithography

DCX PCI300 Features

Powerful & Flexible DSP / FPGA Architecture

In addition to a powerful MIPS RISC CPU, the DCX-PCI 300 has a 40 MHz DSP dedicated to each axis module - guaranteeing reliable, deterministic performance regardless of the number of axes controlled. Additionally, high-capacity Field Programmable Gate Arrays (FPGA's) allow customization of the controller's hardware interface for specialized OEM applications. Custom functions implemented in hardware will run much faster than if implemented in software as in many competing systems. With this flexible architecture, in as little as a day PMC can customize a DCX-PCI 300 controller to provide powerful new functionality to meet the unique requirements of even 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 Windows 98 and Windows 2000/NT/XP. 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 PCI 300 "API Reference 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".

Easy-to-Use Embedded Command Language

High-level programming 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 features conditional branching (If...Then...), callable macros and other elements of structured programming. Using the controller's multi-tasking capability, up to 10 MCCL routines can run concurrently, freeing the host PC for other tasks.

Flexible Servo & Stepper Control

The DCX-PCI 300 motion controller can be easily configured to control up to 16 servo and step motors with a variety of plug-in modules. Up to 8 axis modules can be mixed and matched in any combination on a single controller board. Module choices include:

- Servo Module
- Sine Commutating Servo Module
- Stepper Module
- Dual Servo Module
- Dual Stepper Module
- Analog I/O Module (for extra I/O)
- Digital I/O Module (for extra I/O)
- Custom Modules

For servo control, the DCX-MC300 Servo Control Module provides a standard +/- 10 VDC analog control signal for use with servo amplifiers or drives, and the DCX-MC320 Sine Commutating Servo Module provides sinusoidal commutation for controlling AC brushless sine motors. For stepper control, the DCX-MC360 Stepper Module provides step/direction or a CW/CCW signal.

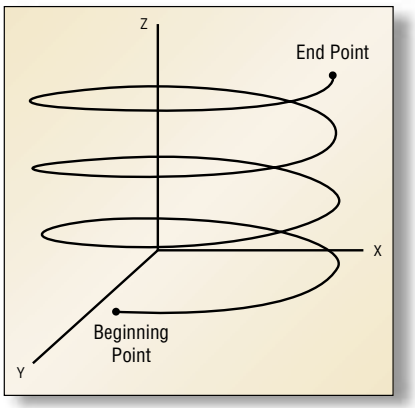


Figure 1: 3-D Motion

Additionally, for axes that don't require certain advanced features, such as an auxiliary encoder, we offer Dual versions of the standard servo and stepper modules. Dual-axis modules can control up to 2 motors each, for highly cost-effective control of up to 16 motors from a single DCX-PCI 300 controller.

For volume OEM's, custom modules can be designed to provide functionality and performance tailored to highly specialized applications.

Superior Stepper Accuracy

DCX-300 Series motion controllers can ensure the most reliable and repeatable stepper positioning possible by closing the loop with position feedback from an encoder. This allows end-of-move stepper position verification & correction, as well as true closed loop motion, which compensates on-the-fly for friction and load torque variations to ensure that motion remains consistent, accurate and repeatable throughout the move.

High-Speed Communication and Command Execution

With Dual Ported Memory, a high-speed PCI bus, and generous multi-processing power, the DCX-PCI 300 controller provides lightning-fast communication to and from the host computer. The card offers the option of communicating via either the High-Speed Binary Interface or an easy-to-use ASCII Interface. For applications that require maximum command throughput, the High-Speed Binary Interface can execute up to 20,000 interrogate-execute-reply sequences per second through a memory-mapped command buffer. This results in reliable execution of time-critical motion and I/O operations, while allowing the host computer to quickly move on to other tasks.

Sinusoidal Commutation of AC Brushless Motors

Using the DCX-MC320 Commutating Servo Module, the DCX-PCI 300 controller generates sinusoidal commutation signals to control AC brushless sine motors with superior accuracy and smoothness. Each commutating axis module 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 brushless applications.

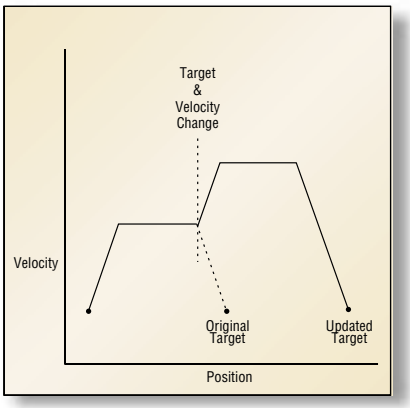


Figure 2: On-the-fly Parameter & Target

Multi-Tasking

DCX-300 Series motion control cards provide true on-board multi-tasking command execution. In addition to simultaneously controlling up to16 axes 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.

DCX PCI 300 Features

On-the-fly Parameter and Target Changes

The DCX-PCI 300 motion controller 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.

S-Curve, Parabolic and Trapezoidal Velocity Profiles

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

Electronic Gearing, Master/Slave & Gantry Control

As many as six axes can be electronically geared to a master axis which may be a motor controlled by the DCX-300 Series card or an external encoder source. Each axis will follow the master axis at its specified gear ratio. Gantry control is a common application requiring gear ratios. PMC's servo tuning utility includes features tailored to the unique requirements of gantry control.

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

The DCX-PCI 300 can perform linear interpolation and circular contouring simultaneously on one to sixteen 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 counter-clockwise circle, etc. Programmable parameters include Vector Feed Rate (vector velocity), Vector Acceleration, and Vector Deceleration. All of these parameters can be changed on-the-fly.

High-Speed Position Capture Inputs & Position Compare Outputs

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

Robust High-Density Connectors & Cables

For enhanced mechanical robustness, ease of assembly and electrical noise immunity, VHDCI connectors are offered on the DCX-PCI 300 motion controller. This option provides 4 convenient 68 pin VHDCI connectors on the PCI card's end-bracket, which route all control and axis I/O signals for up to 16 axes from the DCX-PCI 300 controller to amplifiers and external I/O. Ribbon cabling is also offered as an alternative to the VHDCI option.

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-PCI 300 firmware is always available for download in the Support section of PMCís web site, at www.pmccorp.com.

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 high-resolution graphical plotting utility for tuning the PID filter characteristics of a servo. This easy-to-use tool 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.

Listed here are just a few of the significant features of the DCX-PCI 300 Series Controller. A comprehensive description of all features is provided in the DCX-PCI 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



Pecision x-y grinding



Figure 3: A 'C' sample program with source code



Figure 4: Interactive Servo Tuning with error plotting

DCX PCI300 Specifications

Processor

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

Communications

- PCI-bus via Dual-Ported DRAM
- High-speed binary communication
- PCI-bus interrupt capability

Programming

- Programmable in C/C++, Visual Basic or Delphi (Pascal)
- LabVIEW/BridgeVIEW support via the Motion VI Library
- Native drivers for DOS, Windows 98 & Windows NT/2000/XP
- 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 to 16 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 16 axes
- Spline interpolation of up to 16 axes
- Multi-axis contouring
- Electronic gearing
- Position, velocity, torque and gain control modes
- High-speed position capture input
- High-speed position compare output
- Backlash compensation
- Change motion trajectory & parameters on-the-fly
- Custom motion capabilities available upon request

Memory

- 4 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
- User-defined notch filtering
- Selectable servo update rate 2,4, or 8 KHz (up to 16 axes)

Stepper Control

- Pulse/direction or CW/CCW stepper control
- 5 MHz maximum step rate each axis (up to 16 axes),
- 50% pulse train duty-cycle at all pulse rates
- Full/half step, full/half current control signals
- Closed-loop control (with DCX-MC 360 module)

Position Feedback

- Quadrature incremental encoder with index
- 10 MHz encoder count rate per axis (up to 16 axes)
- Single-ended or differential inputs (A+, A-, B+, B-, I+, I-)
- Auxiliary encoder (A+, A-, B+, B-, I+, I-)
- Digital noise filtering
- 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 0.5 microsecond latency plus output buffer delay)

General Purpose I/O

- 16 digital I/O on motherboard, 8 inputs and 8 outputs
- Up to 128 additional software configurable digital I/O
- Up to 64 additional analog I/O, 12-bit resolution

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

- Four high-density 68 pin VHDCI connectors on PCI card end-bracket for all control, feedback and I/O signals (std.)
- 26 pin dual-row IDC ribbon header for each axis module (opt.)
- 26 pin dual-row IDC ribbon header for on-board digital I/O (std.)
- 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) R.H. non-condensing
- Size: 314mm x 107mm (12.3" x 4.2")

Part Numbers/Descriptions

Motherboards

Description	Part Number
1-16 axes PCI-bus motion control motherboard (Must specify configuration)	DCX-PCI300-?
Configurations available	
High-Density Cable Connections: Four 68-pin VHDCI connectors on end-bracket	DCX-PCI300-H
Ribbon Cable Connections: One 26-pin IDC ribbon cable connector per axis module	DCX-PCI300-R

Plug-in Modules & Accessories

Description	Part Number
High-Density Cable Configuration	
DC Servo Control Module (+/- 10 volt control output)	DCX-MC300-H
AC Brushless Servo Control Module (Sine commutation control output)	DCX-MC320-H
Stepper Control Module (Pulse & direction or CW/CCW control output)	DCX-MC360-H
Dual-Servo Control Module (Controls two DC servo motors)	DCX-MC302-H
Dual-Stepper Control Module (Controls two stepper motors)	DCX-MC362-H
16 Channel Digital I/O Module	DCX-MC400-H
12 bit Analog I/O Modules	
4 Channel Analog Input plus 4 Channel Analog Output	DCX-MC500-H
4 Channel Analog Input	DCX-MC510-H
4 Channel Analog Output	DCX-MC520-H
Ribbon Cable Configuration	
DC Servo Control Module (+/- 10 volt control output)	DCX-MC300-R
AC Brushless Servo Control Module (Sine Commutation control output)	DCX-MC320-R
Stepper Control Module (Pulse & direction or CW/CCW control output)	DCX-MC360-R
16 Channel Digital I/O Module	DCX-MC400-R
12 bit Analog I/O Modules	
4 Channel Analog Input plus 4 Channel Analog Output	DCX-MC500-R
4 Channel Analog Input	DCX-MC510-R
4 Channel Analog Output	DCX-MC520-R

Optional Accessories

Description	Part Number
High-Density Cable Configuration	
2-axis Interconnect Board (68-pin VHDCI connector-to-wiring terminals)	DCX-BF3XX-H
6 ft. (1,84 meter) High-Density Interconnect Cable (for 1-2 axes)	DCX-PCICBL-H
Relay Rack Interface for general purpose digital I/O on motherboard:	
16 Channel (Plug-compatible with Opto 22 and Grayhill)	DCX-BF022
Ribbon Cable Configuration	
Single Axis Interconnect Breakout Boards	
For DC Servo Control Module, DCX-MC300-R	DCX-BF300
For AC Brushless Servo Control Module, DCX-MC320-R	DCX-BF320
For Stepper Module , DCX-MC360-R	DCX-BF360
Relay Rack Interface: 16 Channel (Plug-compatible with Opto 22 and Grayhill)	DCX-BF022
DCX Module Ribbon Cable: For DCX-BF300/BF360/BF022	95-020-A
DCX Module Connector Kit: Crimp pins (26 pcs.) and connector housing	95-050-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 application.
- 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.



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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  - 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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