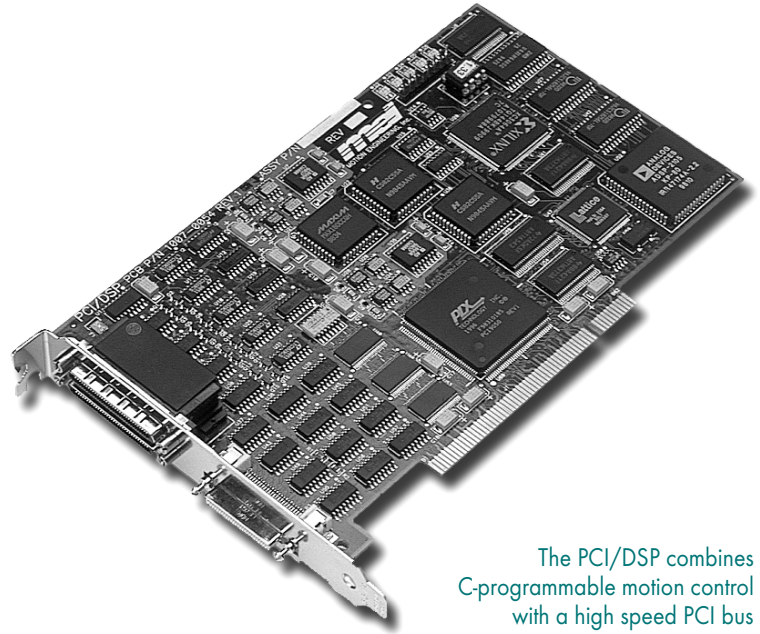


C-programmable Motion Controller

PCI/DSP



The PCI/DSP combines C-programmable motion control with a high speed PCI bus

4 axis model

C-programmable using MEI standard C function libraries (over 250 functions)

Fast host communication across PCI bus

Shielded high-density connectors

Supports both servos and steppers

24 user I/O lines

16-bit servo output resolution

550 kHz step/direction output

Point-to-point and coordinated motion

Supports Windows NT, Windows 95/98, VxWorks, and DOS

Flexible DSP architecture allows on-the-fly changes to many motion parameters

The PCI/DSP uses a powerful Analog Devices DSP to provide 4 axes of servo or stepper control in a single PCI bus slot. Hardware features include 16-bit servo outputs, encoder inputs to 5 MHz, and 24 lines of opto-isolated user I/O.

You program the PCI/DSP using MEI's flexible C function libraries with over 250 motion control functions. Combining MEI C libraries with compilers from Microsoft, Borland, Watcom, and others speeds development of complex motion applications.

The PCI/DSP provides a rich set of software algorithms, including a sophisticated second-order PID control algorithm with velocity, acceleration, and friction feed-forward.

Advanced features include electronic gearing and camming, dual-loop control, circular and linear interpolation, and trapezoidal, S-curve, parabolic, and custom motion profiles.

The PCI/DSP allows motion control programs to share execution between the on-board DSP (for numerically intensive real-time functions) and the host (for non-real-time functions). This results in an ideal division of labor with minimal host intervention.

Software Features

Powerful C-programming Libraries The PCI/DSP draws both its power and flexibility from MEI's C function libraries.

These libraries enable applications developed on the PCI/DSP to run on any MEI motion controller.

```
set_move_speed(speed);
set_move_accel(accel);
start_point_list();
move_2(x1,y1);
move_2(x2,y2);
end_point_list();
```

Sample coordinated motion routine

The MEI C libraries contain over 250 functions you can use to create motion control programs from simple point-to-point motion to complex multi-axis coordinated motion. Along with source code, MEI provides hundreds of sample applications to help speed development.

Development Environment MEI controllers support most popular compilers and operating systems, including those with true multitasking.

Operating Systems	Compilers
Windows NT	Microsoft Visual C/C++
Windows 95	Borland C/C++
Windows 98	Watcom C/C++
DOS	Visual BASICS for Windows
VxWorks	GNU

***PID and Notch Filters** The PCI/DSP uses a software PID control algorithm optimized for high performance. This PID algorithm delivers quick update rates, stable operation, and easy tuning. An optional post-PID notch filter is available to eliminate mechanical resonances in a closed-loop system (optional at no cost in volume).

```
while (! done)
{ printf("Set SlavingRatio? ") ;
  gets(buffer) ;
  done=scanf(buffer,"%lf",&ratio)!=1;
  if (! done)
  { endlink (SLAVE);
    set_position(3,0) ;
    set_position(1,0) ;
    link(3,1, ratio, ACTUAL) ;
  }
}
```

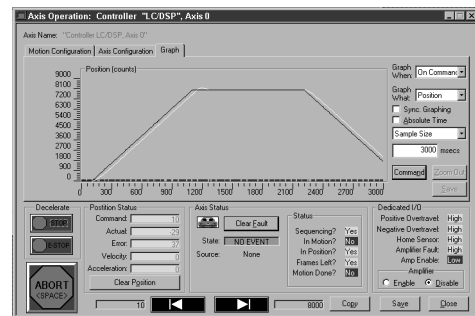
Sample master/slave routine

*Optional at no cost in volume

Powerful Frame Architecture To create a motion sequence, the DSP executes a series of "frames" generated by the MEI C library and sent from the host. Each frame specifies trajectory calculation variables as well as the trigger point for determining when the next frame should be executed.

Setup and Tuning Tools To set up and configure your system, you can use Motion Console, a Windows-based program that lets you spin motors with just a few mouse clicks.

Using Motion Console, you can install and configure multiple controllers, modify tuning parameters, check axis status, and graph motion in real time.

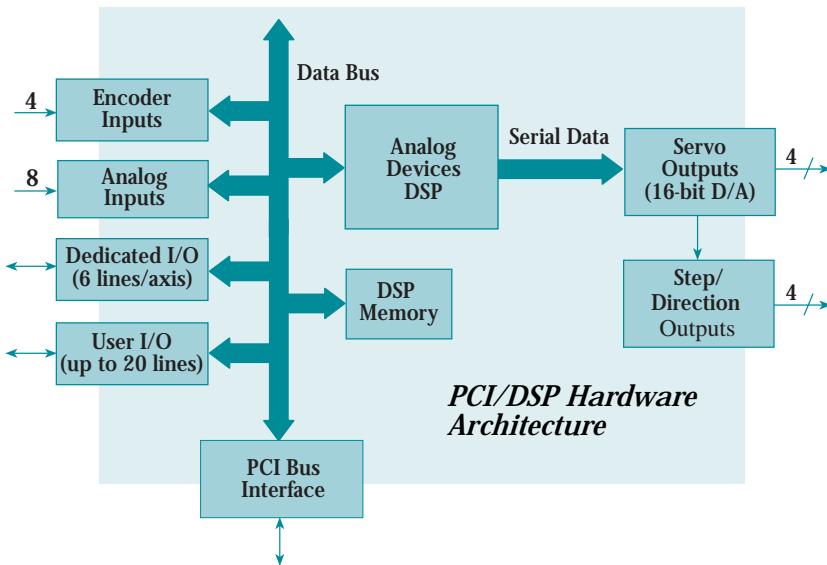


Variety of Motion Profiles With a single C function, you can program independent or simultaneous point-to-point motion for up to four axes (with your choice of trapezoidal, parabolic, S-curve, or user-defined profiles). You can trigger I/O bits on-the-fly for specified positions, velocities, or times.

Advanced Motion Features

- electronic gearing & camming
- coordinated motion with acceleration blending, cubic splining, or circular interpolation
- feed-speed override with pause-on-path
- tangential following and laser power control*
- position latching (under 4 microseconds)
- analog & encoder-based jogging
- sinusoidal commutation*
- dual-loop control
- linear interpolation
- high-speed registration
- direct data acquisition (A/D & D/A)

Hardware Features



High-Performance DSP Architecture The PCI/DSP uses a high-performance DSP to execute real-time motion control algorithms, offloading non-real-time functions to the host. The PCI/DSP buffers commands from the host and stores motion and I/O sequences on-board.

This efficient division of labor frees the host from real-time requirements and enables fast host-to-DSP communication across the PCI bus. Even complex functions require virtually no CPU time once motion starts.

Fast Communications The host compiles C functions and transmits them as binary strings across the high speed PCI bus. While the DSP can interrupt the host to request data or initiate other actions, no host involvement is required once compiled commands are downloaded.

The host CPU can access all on-board peripheral functions (such as digital I/O) without interrupting the real-time control loop calculations of the DSP.

```
set_feedback(linear, ENCODER);
set_feedback(rotary, ENCODER);
set_dual_loop(linear, rotary, TRUE);
```

Sample dual-loop control routine

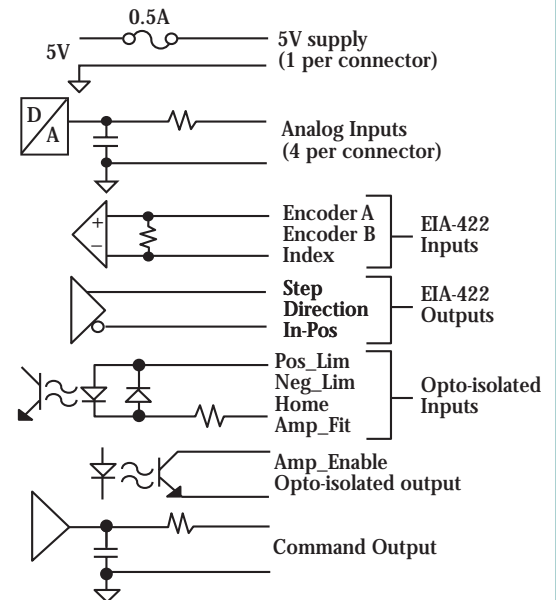
Fast bus communications also allow the PCI/DSP to take full advantage of ever-expanding host CPU performance.

Position Feedback Up to four encoder inputs accept position feedback at up to 5 MHz. With MEI's unique Encoder Integrity Checking (EIC) feature, on-board encoder inputs can detect broken or shorted encoder wires, detect an illegal state, and digitally filter serious noise. EIC ensures that problems with either the encoder or its wiring won't result in a runaway condition.

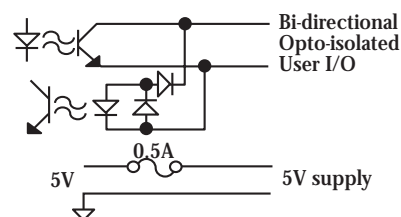
Hardware features

- 16-bit servo output resolution
- 32-bit or 48-bit accuracy in all kinematic functions (position, velocity, and acceleration)
- shielded high-density connectors
- support for servo and steppers on one board
- step output rates up to 550 kHz

VHDCI-68 Connector (2 per PCI/DSP)



VHDCI-50 Connector (1 per PCI/DSP)



PCI/DSP Specifications

Processor

- Analog Devices, 10-20 MHz DSP

Computer Interface

- PCI bus Compatible
- Binary communication up to 30 Mbytes/sec
- Host CPU interrupts

Software Development Tools

- MEI standard C function libraries (over 250 functions)
- Compilers: Microsoft, Borland, Watcom, GNU
- Operating system support: Windows NT, Windows 95/98, VxWorks, and DOS

Servo Loop Update Rate

- User-programmable rate
- Maximum: 7.1 kHz (1 axis), 2.7 kHz (4 axes)
- Default: 1.25 kHz

Servo Output

- $\pm 10V$ DC at 16-bit resolution
- ± 18 mA current
- 100 ppm long-term velocity accuracy

Step Output

- Pulse rate ranges (16-bit resolution):
 - 0 to 550 kHz
 - 0 to 300 kHz
 - 0 to 75 kHz
 - 0 to 17 kHz
- RS-422 line driver outputs
- ± 20 mA current
- Step/direction or clock up/clock down
- Pulse width: 50% duty cycle

Position Feedback

- Incremental encoder: 5 MHz, single-ended or differential
- EIA-422 line receivers/digital filtering
- Encoder checking: broken wire and illegal state detection
- Analog position feedback

Dedicated I/O (per axis)

- Five opto-isolated signals per axis, 5V - 24V logic: Home, Positive Limit, Negative Limit, Amp Fault Inputs
- Opto-isolated Amp_Enable Output
- 6 EIA-422 signals per axis: Step, Direction, In_Position outputs, Encoder A, B, Index Inputs

User I/O (per board)

- 24 lines of bi-directional user I/O
- Opto-isolated
- 5V - 24V
- 10 mA source or sink

Kinematic Ranges

- Position: 32-bit (± 2.15 billion counts)
- Velocity: 48-bit (± 65 million counts/sec at 2 kHz sampling)
- Acceleration: 48-bit (± 131 billion counts/sec² at 2 kHz sampling)
- Jerk: 48-bit (± 262 trillion counts/sec³ at 2 kHz sampling)

Motion Control Features

- Point-to-point motion
- Coordinated motion
- Cubic spline motion
- Electronic gearing and camming
- Feed speed override
- Dual-loop control
- High inertia compensation
- High-speed registration
- Tangential following*
- Laser power*
- Sinusoidal commutation*

Motion Profiles

- Trapezoidal profile
- S-curve profile
- Parabolic profile
- Custom (user-defined)

Connectors

- 68-pin VHDCI connectors for motion interface signals
- 50-pin VHDCI connectors for user I/O signals

Power Requirements

- +5 V I_{cc} = 0.8 A max
- +12V I_{cc} = 10 mA max
- -12V I_{cc} = 20 mA max

Environmental Conditions

- Operating temperature: 0-50 degrees C
- Humidity: 20-95% RH, non-condensing

Construction

- Full SMT; 4-layer PCB
- 100% bed of nails and fully functionally tested with 24-hour burn-in

Analog Inputs (per board)

- 8 channels, 12-bit A/D
- Configurable for 4-channel differential mode
- 75 kHz sampling rate
- Unipolar (0-5V) or bipolar ($\pm 2.5V$)
- Direct access from host processor



Corporate Headquarters

33 South La Patera Lane
Santa Barbara
California 93117-3214
ph (805) 681-3300
fax (805) 681-3311
e-mail info@motioneng.com
www.info@motioneng.com

Eastern Regional Office

ph (978) 264-0051

Philadelphia Development Office

ph (215) 793-4220

Nagoya Technical Support Office

ph 0532-45-3511

Japan Regional Office

ph 03-5540-6431

e-mail info@motioneng.co.jp

European Regional Office

ph 49 (0) 8122 961750

All trademarks are the property of respective owners.
All specifications are subject to change without notice.
Rev. 2/00

*Optional at no cost in volume