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DSP
ISA
Analog

C-programmable Motion Controller

PCX/DSP



The PCX/DSP combines a 40 MHz DSP with MEI's extensive C function libraries.

- *C-programmable using MEI standard C function libraries (over 250 functions)*
- *Single-slot ISA card supports up to 8 axes*
- *Fast host communication across ISA bus*
- *Supports both servos and steppers*
- *Up to 44 user I/O lines*
- *16-bit servo output resolution*
- *375 kHz step/direction output*
- *Point-to-point and coordinated motion*
- *Supports Windows NT, Windows95, Windows 3.X, DOS, VxWorks, Lynx/OS, pSOS, and QNX*
- *Flexible DSP architecture allows on-the-fly changes to many motion parameters*

The PCX/DSP motion controller uses a powerful Analog Devices 40 MHz DSP to provide up to 8 axes of servo or stepper control in a single ISA bus slot. Hardware features include 16-bit servo outputs, encoder inputs to 5 MHz, 8 channels of 12-bit analog inputs, and up to 44 lines of user I/O.

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

The PCX/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 PCX/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.

Motion Engineering, Inc.

Software Features

Powerful C-programming Libraries The PCX/DSP draws both its power and flexibility from MEI's C function libraries. These libraries enable applications developed on the PCX/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
DOS	Microsoft Visual C/C++
Windows 3.X	Borland C/C++
Windows NT	Watcom C/C++
Windows95	Symantec C/C++
Lynx/OS	Visual BASIC for Windows
VxWorks	GNU
QNX	
pSOS	

PID and Notch Filters The PCX/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.

```
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 coordinated motion routine

Powerful Frame Architecture To create a motion sequence, the DSP executes a series of "frames" that are generated by MEI C library functions and sent from the host. Each frame is an array of 20 words that contain position, velocity, acceleration, jerk, I/O status, and trigger information.

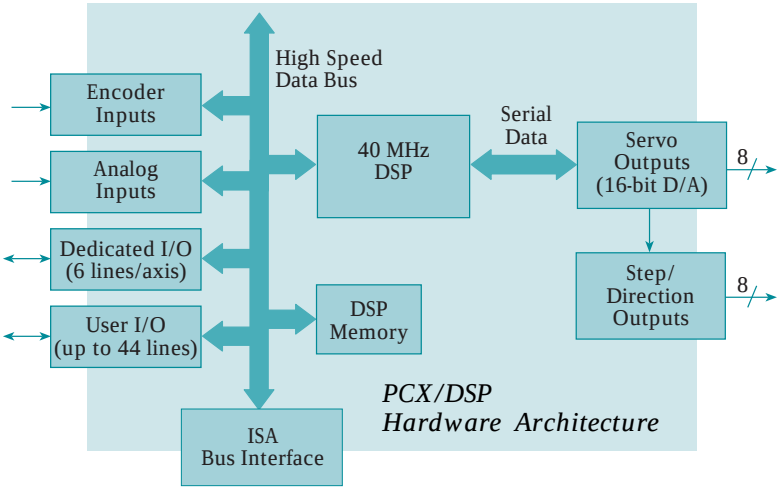
With up to 600 frames stored on-board, the PCX/DSP can buffer complex motion sequences in memory for minimal host involvement. The host downloads frames and the PCX/DSP executes them. For additional frames, either the host polls the board's buffer status or the PCX/DSP sends an interrupt to the host.

Variety of Motion Profiles With a single C function, you can program independent or simultaneous point-to-point motion for up to eight 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 and encoder-based jogging
- sinusoidal commutation
- dual-loop control
- multiple coordinate systems
- helical and linear interpolation
- analog scale interpolation
- high-speed registration
- direct data acquisition (A/D and D/A)

Hardware Features



High-Performance DSP Architecture The PCX/DSP uses a high-performance 40 MHz DSP to execute real-time motion control algorithms, offloading non-real-time functions to the host. The PCX/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 ISA 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 ISA bus at speeds up to 1.2 Mbytes/sec. 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 and analog inputs) 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 PCX/DSP to take full advantage of ever-expanding host CPU performance by leveraging the multitasking capabilities of the Windows NT operating system.

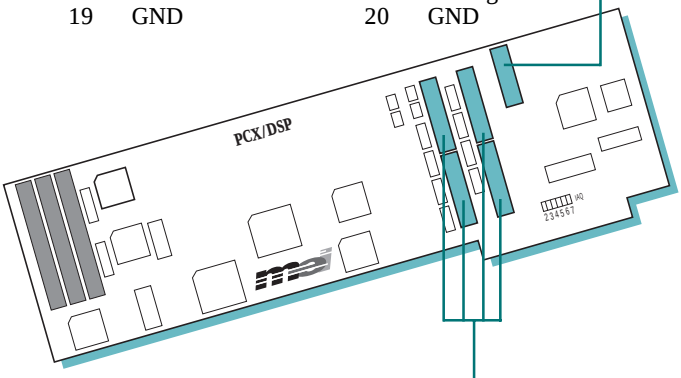
Position and Analog Feedback Up to eight encoder inputs accept position feedback at up to 5 MHz. With MEI's unique Encoder Integrity Checking (EIC) feature, on-board encoder inputs can detect broken or shorted encoder wires, detect an illegal state, and digitally filter serious noise. EIC ensures that 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)
- no arcane proprietary command languages
- support for servo and steppers on one board
- step output rates up to 375 kHz
- optional support for Temposonics sensors

Analog Input/Counter-Timer Pin-outs

Pin	*Signal*	*Pin*	*Signal*
1	GND	2	GND
3	Clock 0	4	Analog in 0
5	-12 V	6	Analog in 1
7	+12 V	8	Analog in 2
9	+5 V	10	Analog in 3
11	Gate 0	12	Analog in 4
13	Out 0	14	Analog in 5
15	Out 1	16	Analog in 6
17	Out 2	18	Analog in 7
19	GND	20	GND



Motor/Encoder Pin-outs

Pin	*Signal*	*Pin*	*Signal*
1	GND	2	5V
3	Encoder A+	4	Encoder A-
5	Encoder B+	6	Encoder B-
7	Encoder Index +	8	Encoder Index -
9	±10 V Analog Out	10	Step Pulse + *
11	Step Pulse - *	12	Direction + *
13	Direction - *		

* *Clock up/down optional*

PCX/DSP Specifications

Processor

- Analog Devices, 40 MHz DSP

Computer Interface

- ISA Compatible
- Switch-selectable address, I/O mapped
- Binary communication to 1.2 Mbytes/sec
- Host CPU interrupts

Software Development Tools

- MEI standard C function libraries (over 250 functions)
- Compilers: Microsoft, Borland, Watcom, Symantec, GNU
- Operating system support: Windows NT, Windows95, Windows 3.X, DOS, VxWorks, Lynx/OS, pSOS and QNX

Servo Loop Update Rate

- User-programmable rate
- Maximum: 10 kHz (1 axis), 3.0 kHz (4 axes), 1.6 kHz (8 axes)
- Default: 1.25 kHz

Servo Output

- ±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 375 kHz
  0 to 93.75 kHz
  0 to 23 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
- RS-422 line receivers/digital filtering
- Analog position feedback
- Encoder checking: broken wire and illegal state detection
- Temposonics support: direct connection*

Dedicated I/O (per axis)

- TTL compatible, 4.0 mA drive
- Inputs: positive and negative limits, home, amp-fault (SCR clamp protected)
- Outputs: in-position, amp-enable

User I/O (per board)

- 2/4 axis models: 44 lines
  6/8 axis models: 24 lines
- TTL compatible, 4.0 mA drive
- Direct access from host CPU

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 (± 2.5V)
- Direct access from host processor

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/sec^2 at 2 kHz sampling)
- Jerk: 48-bit (262 trillion counts/sec^3 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*
- Sinusoidal encoder interpolation*

Motion Profiles

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

Power Requirements

- +5 V Icc = 0.9 A max
- +12V Icc = 10 mA max
- -12V Icc = 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
- UL and CE compliant

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