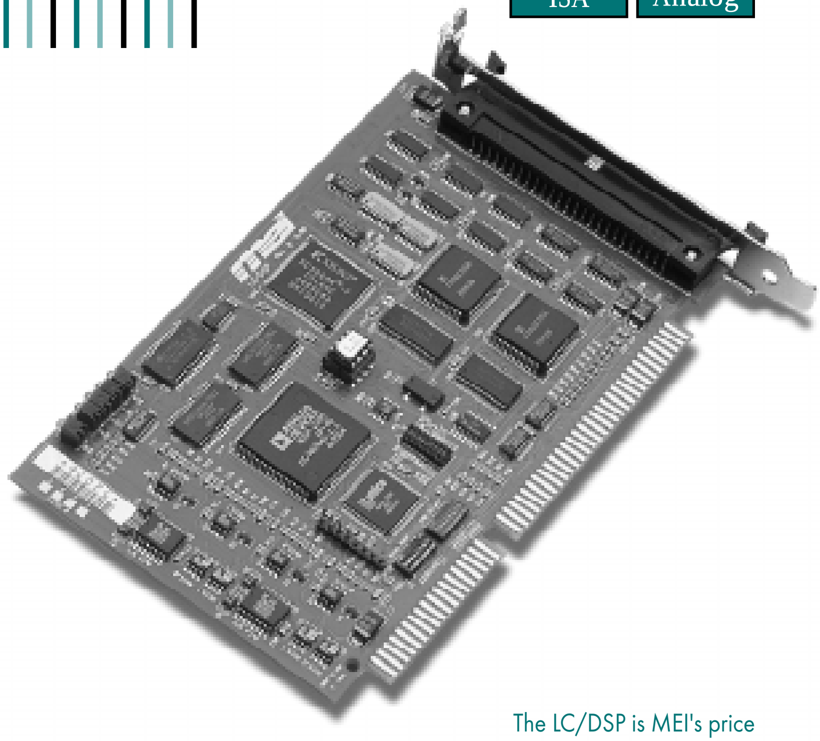
ISA Analog

C-programmable Motion Controller

LC/DSP



The LC/DSP is MEI's price and performance leader, combining an Analog Devices DSP with extensive C function libraries.

- *1, 2, 3, and 4 axis models*
- *C-programmable using MEI standard C function libraries (over 250 functions)*
- *Fast host communication across ISA bus*
- *Supports both servos and steppers*
- *20 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*

Motion Engineering, Inc.

The LC/DSP offers excellent price and performance in a single-board motion controller. A powerful Analog Devices DSP provides up to 4 axes of servo or stepper control in a single ISA bus slot. Hardware features include 16-bit servo outputs, encoder inputs to 5 MHz, and 20 lines of user I/O.

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

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

PID and Notch Filters The LC/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.

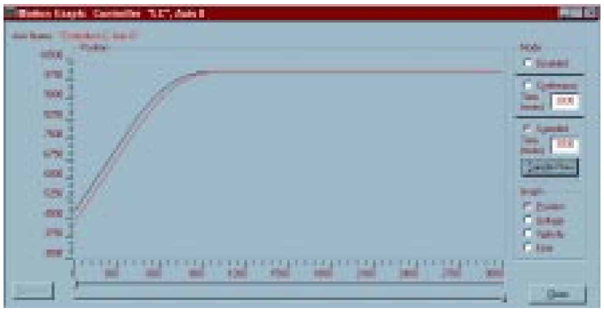
```
while (! done)
{  printf("Set SlavingRatio? ") ;
   gets(buffer) ;
   done=scanf(buffer,"%lf",&ratio)!=1;
   if (! done)
   {  endlink (SLAVE);
      set_position(3,0) ;
      set_position(1,0) ;
      link(3,1, ratio, ACTUAL) ;
   }
}
```

Sample coordinated motion routine

Powerful Frame Architecture To create a motion sequence, the DSP executes a series of "frames" 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.

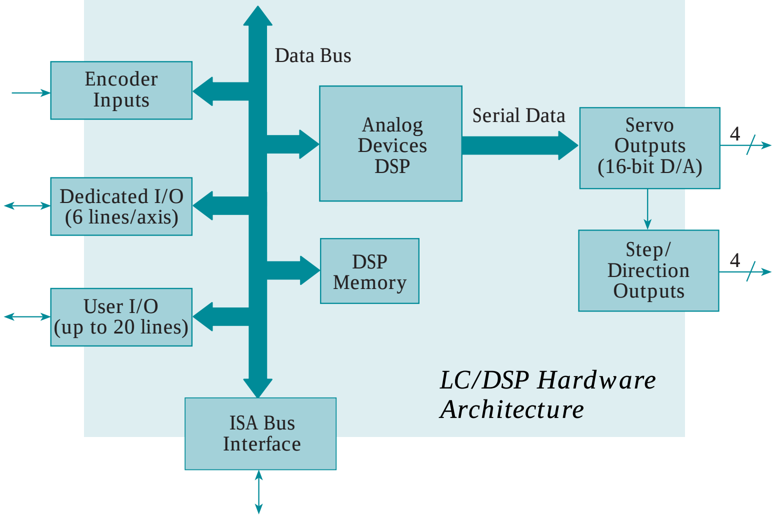


Variety of Motion Profiles With a single C function, you can program independent or simultaneous point-to-point motion for up to four axes (with your choice of trapezoidal, parabolic, S-curve, or user-defined profiles). You can trigger I/O bits on-the-fly for specified positions, velocities, or times.

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)
- encoder-based jogging
- sinusoidal commutation
- dual-loop control
- linear interpolation
- high-speed registration
- direct D/A outputs

Hardware Features



LC/DSP Hardware Architecture

High-Performance DSP Architecture

The LC/DSP uses a high-performance DSP to execute real-time motion control algorithms, offloading non-real-time functions to the host. The LC/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 MB/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) 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 LC/DSP to take full advantage of ever-expanding host CPU performance by leveraging the multitasking capabilities of the Windows NT operating system.

Position Feedback

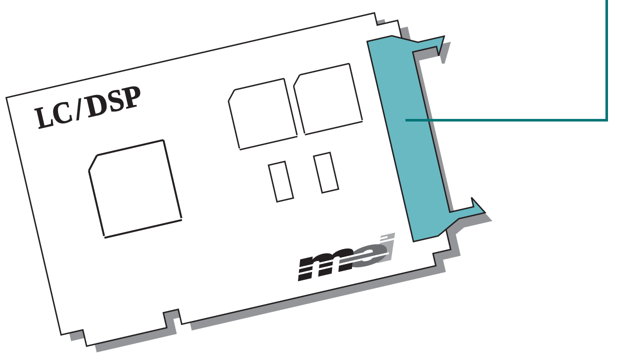
Up to four encoder inputs accept position feedback at up to 5 MHz. With MEI's unique Encoder Integrity Checking (EIC) feature, on-board encoder inputs can detect broken or shorted encoder wires, detect an illegal state, and digitally filter serious noise. EIC ensures that problems with either the encoder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

Motor/Encoder Pin-outs

Pin	*Signal*	*Pin*	*Signal*
1	+5V*	27	Positive Limit(0)
3	Encoder A(0) +	29	Negative Limit(0)
5	Encoder A(0) -	31	Home Input(0)
7	Encoder B(0) +	33	Amp Fault(0)
9	Encoder B(0) -	35	Amp Enable(0)
11	Encoder Index(0) +	37	In Position (0)
13	Encoder Index(0) -	39	User I/O PA0
15	±10V Analog Out(0)	41	User I/O PA1
17	GND	43	User I/O PA2
19	Step Pulse (0)+*	45	User I/O PC0
21	Step Pulse (0) -*	47	User I/O PC1
23	Direction(0) +*	49	GND
25	Direction(0) - *		



NOTE: One axis connection shown; 100-pin high-density connector supports up to 4 axes

** Clock up/down optional*

LC/DSP Specifications

Processor

- Analog Devices, 10-20 MHz DSP

Computer Interface

- ISA Compatible
- Switch-selectable address, I/O mapped
- Binary communication up 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)
- 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
- Encoder checking: broken wire and illegal state detection

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)

- 20 lines, user programmed mode: input or output
- TTL compatible, 4.0 mA drive
- Direct access from host CPU

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*

Motion Profiles

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

Power Requirements

- +5 V Icc = 0.8 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

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