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.

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
- Windows NT
- Windows 95
- Windows 3.X
- DOS
- VxWorks
- Lynx/OS
- pSOS
- QNX

Compilers
- Microsoft Visual C/C++
- Borland C/C++
- Watcom C/C++
- Symantec C/C++
- Visual BASIC for Windows
- GNU

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

```
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

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

**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.

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.

**Motor/Encoder Pin-outs**

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

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/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)

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

Motion Engineering is represented by: