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High-Performance Stepper/Servo Motion Controllers

NI 735x

- Up to 8 axes of motion
- Configurable stepper or servo control
- Up to 4 MHz stepper output rate
- 62 μ s PID loop update rate for up to 2 axes
- 3D linear and circular interpolation
- 3D contouring
- Sinusoidal commutation for brushless motors
- Buffered breakpoints for high-speed integration
- Patented step generation technology for smooth stepper motion

Operating Systems

- Windows Vista/XP/2000
- LabVIEW Real-Time

Recommended NI Software

- LabVIEW
- NI Motion Assistant
- LabWindows™/CVI
- Measurement Studio

Other Compatible Software

- Visual Basic
- C/C++

Driver Software (included)

- NI-Motion



Overview and Applications

NI 735x PCI and PXI stepper and servo motion controllers are for machine builders and users who need the highest performance and a high-axis count in a small space. The NI PXI-7358 is the first 8-axis stepper or servo motion controller packaged as a 1-slot 3U PXI module. It offers many advanced features, including sinusoidal commutation for brushless motors. NI 735x motion controllers are available in 2-, 4-, 6-, and 8-axis versions for PXI and PCI.

Motion Control and LabVIEW Real-Time

Many motion applications require very high reliability and integration with other types of I/O. NI PXI motion controllers are compatible with the NI LabVIEW Real-Time Module, with which you can create an integrated motion and I/O system that runs embedded in a real-time OS. A PXI motion controller with a PXI RT Series controller can run LabVIEW Real-Time and function as a stand-alone Ethernet-based motion controller. With this technology, you can create distributed motion control systems that integrate tightly with data acquisition or vision.

I/O Capabilities

NI 735x motion controllers have diverse I/O that is useful in many motion applications. You can use the 64 bits of digital I/O for a wide variety of applications such as opening or closing valves or turning on and off solid-state relays using the SSR adapter. These motion controllers also have eight channels of 16-bit analog I/O useful for reading potentiometers or other analog measurements.

Synchronizing Multiple Axes for Parallel Mechanism Applications

Because NI 735x controllers can control up to eight axes, they are ideal for high-axis parallel mechanisms where all axes need to be tightly synchronized. Using the NI-Motion driver software, you can start all axes at once and have each axis follow the acceleration and velocity profiles you have defined. This is useful when working with parallel mechanisms such as hexapods when the axes must move simultaneously.

Static-Friction Compensation

The frictional force present before an object starts moving is called static friction. Static friction is often higher than dynamic friction (frictional force present during motion) and if the difference between the two is large enough, it can make the system difficult to tune. The static-friction compensation feature of the NI 735x motion controllers compensates for this difference in friction for easier tuning and precise control. Piezoelectric systems exhibit high static friction and can benefit from the static friction compensation feature of the NI 7350 series motion controllers. In addition, to help you tune your system, NI offers the free Piezo Tuning Wizard. After tuning your system using the Piezo Tuning Wizard, you can easily program the system using LabVIEW software and NI Motion Assistant just as you would program any other system.



High-Performance Stepper/Servo Motion Controllers

Sinusoidal Commutation

Brushless servo motors require sinusoidal commutation. Although many advanced motor drives have built-in commutation capability, many lower-cost drives require the motion controller to provide commutation. With sinusoidal commutation, offered by the NI 7350, you can obtain the smoothest possible motion with a brushless servo motor and a lower cost drive.

Note that when using the sinusoidal commutation feature, use two axis resources for each drive you connect to. This is because two analog outputs are needed to provide the commutation.

Increasing Integration Speed with New Breakpoint and High-Speed Capture Enhancements

NI 7350 series motion controllers offer buffered breakpoints for precise timing between motion and measurements or vision. Using this feature, you can send a buffer of position breakpoints to the controller that trigger a digital signal upon reaching the positions in the buffer. Buffered breakpoints can trigger at rates as high as 2 kHz. For equally spaced positions, you can use periodic breakpoints to achieve even higher speeds of up to 4 MHz. With periodic breakpoints, you supply a position modulus. Each time the position reaches that modulus position, the breakpoint triggers. Another new feature that enhances integration

speed is the new buffered high-speed position capture for NI 735x controllers. This feature captures positions based on a trigger from an external source or from a data acquisition or machine vision device. The high-speed capture can capture positions at rates of up to 2 kHz per axis.

Additional Features

For the NI 735x controllers, your PID update rate can be 62.5 μ s for up to two axes. This means that for multi-axis applications, the PID rates can be twice as fast as those for previous boards. An NI 735x also has increased resolution for analog-to-digital conversion, giving you high resolution for analog position feedback.

| Feature | NI 735x |
|---|--|
| Number of Axes | 2, 4, 6, 8 |
| PAC Platforms | PCI, CompactPCI/PXI |
| Linear, Circular, Spherical, and Helical Interpolation; Blending | ✓ |
| Trapezoidal, S-Curve Profiles | ✓ |
| Closed-Loop Stepper Control | ✓ |
| Contouring, Electronic Gearing, Onboard Programming | ✓ |
| Sinusoidal Commutation for Brushless Servo Motors | ✓ |
| Buffered Breakpoints, Buffered High-Speed Capture, 4 MHz Periodic Breakpoints | ✓ |
| Number of Axes per 62.5 μ s PID Rate | 2 |
| PWM Lines/DIO Lines/Analog Input Resolution | 2/64/16-bit |
| Maximum Step Output Rate/Encoder Input Rate | 8 MHz/20 MHz |
| Programming API | NI-Motion Driver |
| Software | NI Motion Assistant, NI LabVIEW, C, Visual Basic |

NI 7350 Motion I/O Connector Pinouts

(two 68-pin VHDCI connectors)

| | | | |
|---------------------------|----|----|-----------------------------|
| Axis 1 Dir (CCW) | 1 | 35 | Axis 1 Step (CW) |
| Digital Ground | 2 | 36 | Axis 1 Encoder Phase A |
| Digital Ground | 3 | 37 | Axis 1 Encoder Phase B |
| Axis 1 Home Switch | 4 | 38 | Axis 1 Encoder Index |
| Trigger 1 | 5 | 39 | Axis 1 Forward Limit Switch |
| Axis 1 Inhibit | 6 | 40 | Axis 1 Reverse Limit Switch |
| Axis 2 Dir (CCW) | 7 | 41 | Axis 2 Step (CW) |
| Digital Ground | 8 | 42 | Axis 2 Encoder Phase A |
| Digital Ground | 9 | 43 | Axis 2 Encoder Phase B |
| Axis 2 Home Switch | 10 | 44 | Axis 2 Encoder Index |
| Trigger 2 | 11 | 45 | Axis 2 Forward Limit Switch |
| Axis 2 Inhibit | 12 | 46 | Axis 2 Reverse Limit Switch |
| Axis 3 Dir (CCW) | 13 | 47 | Axis 3 Step (CW) |
| Digital Ground | 14 | 48 | Axis 3 Encoder Phase A |
| Digital Ground | 15 | 49 | Axis 3 Encoder Phase B |
| Axis 3 Home Switch | 16 | 50 | Axis 3 Encoder Index |
| Trigger 3 | 17 | 51 | Axis 3 Forward Limit Switch |
| Axis 3 Inhibit | 18 | 52 | Axis 3 Reverse Limit Switch |
| Axis 4 Dir (CCW) | 19 | 53 | Axis 4 Step (CW) |
| Digital Ground | 20 | 54 | Axis 4 Encoder Phase A |
| Digital Ground | 21 | 55 | Axis 4 Encoder Phase B |
| Axis 4 Home Switch | 22 | 56 | Axis 4 Encoder Index |
| Trigger 4 | 23 | 57 | Axis 4 Forward Limit Switch |
| Axis 4 Inhibit | 24 | 58 | Axis 4 Reverse Limit Switch |
| Digital Ground | 25 | 59 | Host +5 V |
| Breakpoint 1 | 26 | 60 | Breakpoint 2 |
| Breakpoint 3 | 27 | 61 | Breakpoint 4 |
| Digital Ground | 28 | 62 | Shutdown |
| Analog Output 1 | 29 | 63 | Analog Output 2 |
| Analog Output 3 | 30 | 64 | Analog Output 4 |
| Analog Output Ground | 31 | 65 | Reserved |
| Analog Input 1 | 32 | 66 | Analog Input 2 |
| Analog Input 3 | 33 | 67 | Analog Input 4 |
| Analog Reference (Output) | 34 | 68 | Analog Input Ground |

Motion I/O Connector for Axes 1-4

| | | | |
|---------------------------|----|----|-----------------------------|
| Axis 5 Dir (CCW) | 1 | 35 | Axis 5 Step (CW) |
| Digital Ground | 2 | 36 | Axis 5 Encoder Phase A |
| Digital Ground | 3 | 37 | Axis 5 Encoder Phase B |
| Axis 5 Home Switch | 4 | 38 | Axis 5 Encoder Index |
| Trigger 5 | 5 | 39 | Axis 5 Forward Limit Switch |
| Axis 5 Inhibit | 6 | 40 | Axis 5 Reverse Limit Switch |
| Axis 6 Dir (CCW) | 7 | 41 | Axis 6 Step (CW) |
| Digital Ground | 8 | 42 | Axis 6 Encoder Phase A |
| Digital Ground | 9 | 43 | Axis 6 Encoder Phase B |
| Axis 6 Home Switch | 10 | 44 | Axis 6 Encoder Index |
| Trigger 6 | 11 | 45 | Axis 6 Forward Limit Switch |
| Axis 6 Inhibit | 12 | 46 | Axis 6 Reverse Limit Switch |
| Axis 7 Dir (CCW) | 13 | 47 | Axis 7 Step (CW) |
| Digital Ground | 14 | 48 | Axis 7 Encoder Phase A |
| Digital Ground | 15 | 49 | Axis 7 Encoder Phase B |
| Axis 7 Home Switch | 16 | 50 | Axis 7 Encoder Index |
| Trigger 7 | 17 | 51 | Axis 7 Forward Limit Switch |
| Axis 7 Inhibit | 18 | 52 | Axis 7 Reverse Limit Switch |
| Axis 8 Dir (CCW) | 19 | 53 | Axis 8 Step (CW) |
| Digital Ground | 20 | 54 | Axis 8 Encoder Phase A |
| Digital Ground | 21 | 55 | Axis 8 Encoder Phase B |
| Axis 8 Home Switch | 22 | 56 | Axis 8 Encoder Index |
| Trigger 8 | 23 | 57 | Axis 8 Forward Limit Switch |
| Axis 8 Inhibit | 24 | 58 | Axis 8 Reverse Limit Switch |
| Digital Ground | 25 | 59 | Host +5 V |
| Breakpoint 5 | 26 | 60 | Breakpoint 6 |
| Breakpoint 7 | 27 | 61 | Breakpoint 8 |
| Digital Ground | 28 | 62 | Shutdown |
| Analog Output 5 | 29 | 63 | Analog Output 6 |
| Analog Output 7 | 30 | 64 | Analog Output 8 |
| Analog Output Ground | 31 | 65 | Reserved |
| Analog Input 5 | 32 | 66 | Analog Input 6 |
| Analog Input 7 | 33 | 67 | Analog Input 8 |
| Analog Reference (Output) | 34 | 68 | Analog Input Ground |

Motion I/O Connector for Axes 5-8

BUY ONLINE at ni.com or CALL 800 813 3693 (U.S.)

NI 7350 Digital I/O Connector Pinouts

(two 68-pin VHDCI connectors)

| | | | |
|-----------------------------|----|----|-----------------------------|
| +5 V | 1 | 35 | Digital Ground |
| PCLK | 2 | 36 | Digital Ground |
| Reserved | 3 | 37 | Digital Ground |
| Reserved | 4 | 38 | DPull (P1:P4) |
| PWM1 | 5 | 39 | Digital Ground |
| Reserved | 6 | 40 | Reserved |
| Reserved | 7 | 41 | Digital Ground |
| Reserved | 8 | 42 | Digital Ground |
| PWM2 | 9 | 43 | Digital Ground |
| Port 1:bit 0 | 10 | 44 | Port 1:bit 1 |
| Digital Ground | 11 | 45 | Port 1:bit 2 |
| Port 1:bit 3 | 12 | 46 | Digital Ground |
| Port 1:bit 4 | 13 | 47 | Port 1:bit 5 |
| Digital Ground | 14 | 48 | Port 1:bit 6 |
| Port 1:bit 7 | 15 | 49 | Digital Ground |
| Port 2:bit 0 | 16 | 50 | Digital Ground |
| Port 2:bit 1 | 17 | 51 | Port 2:bit 2 |
| Digital Ground | 18 | 52 | Port 2:bit 3 |
| Digital Ground | 19 | 53 | Port 2:bit 4 |
| Digital Ground | 20 | 54 | Port 2:bit 5 |
| Port 2:bit 6 | 21 | 55 | Digital Ground |
| Port 2:bit 7 | 22 | 56 | Digital Ground |
| Port 3:bit 0 | 23 | 57 | Port 3:bit 1 |
| Digital Ground | 24 | 58 | Port 3:bit 2 |
| Port 3:bit 3 | 25 | 59 | Digital Ground |
| Port 3:bit 4 | 26 | 60 | Port 3:bit 5 |
| Digital Ground | 27 | 61 | Port 3:bit 6 |
| Port 3:bit 7 | 28 | 62 | Digital Ground |
| Port 4:bit 0 | 29 | 63 | Port 4:bit 1 |
| Digital Ground | 30 | 64 | Port 4:bit 2/Axis 1, Hall 1 |
| Axis 1, Hall 2/Port 4:bit 3 | 31 | 65 | Digital Ground |
| Axis 1, Hall 3/Port 4:bit 4 | 32 | 66 | Port 4:bit 5/Axis 2, Hall 1 |
| Digital Ground | 33 | 67 | Port 4:bit 6/Axis 2, Hall 2 |
| Axis 2, Hall 3/Port 4:bit 7 | 34 | 68 | Digital Ground |

Digital I/O Connector for Axes 1-4

| | | | |
|-----------------------------|----|----|-----------------------------|
| +5 V | 1 | 35 | Digital Ground |
| Reserved | 2 | 36 | Digital Ground |
| Reserved | 3 | 37 | Digital Ground |
| Reserved | 4 | 38 | DPull (P5:P8) |
| Reserved | 5 | 39 | Digital Ground |
| Reserved | 6 | 40 | Reserved |
| Reserved | 7 | 41 | Digital Ground |
| Reserved | 8 | 42 | Digital Ground |
| Reserved | 9 | 43 | Digital Ground |
| Port 5:bit 0 | 10 | 44 | Port 5:bit 1 |
| Digital Ground | 11 | 45 | Port 5:bit 2 |
| Port 5:bit 3 | 12 | 46 | Digital Ground |
| Port 5:bit 4 | 13 | 47 | Port 5:bit 5 |
| Digital Ground | 14 | 48 | Port 5:bit 6 |
| Port 5:bit 7 | 15 | 49 | Digital Ground |
| Port 6:bit 0 | 16 | 50 | Digital Ground |
| Port 6:bit 1 | 17 | 51 | Port 6:bit 2 |
| Digital Ground | 18 | 52 | Port 6:bit 3 |
| Digital Ground | 19 | 53 | Port 6:bit 4 |
| Digital Ground | 20 | 54 | Port 6:bit 5 |
| Port 6:bit 6 | 21 | 55 | Digital Ground |
| Port 6:bit 7 | 22 | 56 | Digital Ground |
| Port 7:bit 0 | 23 | 57 | Port 7:bit 1 |
| Digital Ground | 24 | 58 | Port 7:bit 2 |
| Port 7:bit 3 | 25 | 59 | Digital Ground |
| Port 7:bit 4 | 26 | 60 | Port 7:bit 5 |
| Digital Ground | 27 | 61 | Port 7:bit 6 |
| Port 7:bit 7 | 28 | 62 | Digital Ground |
| Port 8:bit 0 | 29 | 63 | Port 8:bit 1 |
| Digital Ground | 30 | 64 | Port 8:bit 2/Axis 3, Hall 1 |
| Axis 3, Hall 2/Port 8:bit 3 | 31 | 65 | Digital Ground |
| Axis 3, Hall 3/Port 8:bit 4 | 32 | 66 | Port 8:bit 5/Axis 4, Hall 1 |
| Digital Ground | 33 | 67 | Port 8:bit 6/Axis 4, Hall 2 |
| Axis 4, Hall 3/Port 8:bit 7 | 34 | 68 | Digital Ground |

Digital I/O Connector for Axes 5-8

Ordering Information

| | |
|----------------------------|-----------|
| NI PXI-7358 (8-axis) | 778540-08 |
| NI PXI-7356 (6-axis) | 778540-06 |
| NI PXI-7354 (4-axis) | 778540-04 |
| NI PXI-7352 (2-axis) | 778540-02 |
| NI PCI-7358 (8-axis) | 778440-08 |
| NI PCI-7356 (6-axis) | 778440-06 |
| NI PCI-7354 (4-axis) | 778440-04 |
| NI PCI-7352 (2-axis) | 778440-02 |

Includes NI-Motion software libraries and examples.

Accessories

| | |
|---------------------------|-----------|
| NI Motion Assistant | 778553-01 |
| Wiring Interfaces | |
| NI UMI-7764 | 777978-02 |
| NI UMI-7772 | 778556-01 |
| NI UMI-7774 | 778558-01 |

Power Drives

| | |
|-------------------|-----------|
| NI MID-7604 | 777936-01 |
| NI MID-7602 | 778003-01 |
| NI MID-7654 | 778005-01 |
| NI MID-7652 | 778004-01 |
| P70530 | 780097-01 |
| P70360 | 780098-01 |

BUY NOW!

For complete product specifications, pricing, and accessory information, call 800 813 3693 (U.S.) or go to ni.com/info and enter **ni7350**.

High-Performance Stepper/Servo Motion Controllers

Specifications

Performance

| | |
|----------------------------------|---|
| PID update rate range | 62.5 to 500 μ s/sample |
| Maximum PID update rate | 62.5 μ s/axis |
| 8-axis PID update rate | 250 μ s total |
| Multiaxis synchronization | <1 update sample |
| Trajectory parameters | |
| Absolute position range | $\pm 2^{31}$ counts |
| Maximum relative move size | $\pm 2^{31}$ counts |
| S-curve time range | 1 to 32,767 samples |
| Following error range | $\pm 32,767$ counts |
| Velocity range | Servo: 1 to $\pm 20,000,000$ counts/s |
| Velocity range | Stepper: 1 to 8,000,000 steps/s |
| Acceleration/deceleration | 244 to 512,000,000 counts/s ² at a PID rate of 250 μ s |
| Gear ratio | $\pm 32,767:1$ to $\pm 1:32,767$ |
| Servo control loop modes | |
| PID (Kp, Ki, and Kd) gains | PID, PIVff, S-curve, dual loop |
| PID (Kp, Ki, and Kd) gains | 0 to 32,767 |
| Stepper outputs | |
| Maximum pulse rate | 8 MHz (full, half, and microstep) |
| Minimum pulse width | 50 ns at >4 MHz |
| Step output mode | Step and direction or CW/CCW |
| Voltage range | 0 to 5 V |

System Safety

| | |
|-------------------------------|--------------------------------------|
| Watchdog timer function | Resets board to startup state |
| Shutdown input | Disable all axes and command outputs |

Motion I/O

| | |
|---|--|
| Servo command analog outputs | |
| Voltage range | ± 10 V, 16 bits (0.000305 V/ LSB) |
| Programmable torque (velocity) limits and programmable offset | |
| programmable offset | ± 10 V (-32,768 to +32,767) |
| Encoder inputs | |
| Quadrature, incremental, single-ended | |
| Maximum count rate | 20 MHz |
| Forward, reverse, and home inputs | |
| Number of inputs | 24 (3 per axis) |
| Control | Individual enable/disable, stop on input, prevent motion, find reference |
| Trigger (position capture) inputs | |
| 8 (one per axis) | |
| Maximum buffered capture rate ¹ .. | 2 kHz per axis |
| Breakpoint (position compare) outputs .. | |
| 8 (one per axis), programmable polarity | |
| Maximum periodic rate | 4 MHz |
| Maximum buffered trigger rate ¹ .. | 2 kHz per axis |
| Inhibit/enable output | |
| 8 (one per axis), programmable polarity | |
| Analog inputs | |
| up to 8, 16-bit resolution, ± 10 V range, 25 μ s scan rate | |
| Analog outputs | |
| 8, 16-bit resolution, ± 10 V range | |

¹Assumes a PID update rate of 250 μ s. 2 kHz per axis for PID rates between 62.5 and 250 μ s, and 1 kHz per axis for PID rates greater than 250 μ s. This value must not exceed 8 kHz total for all ongoing buffered breakpoint (position compare) and trigger (position capture) operations.

Digital I/O

| | |
|-----------------------------|--|
| Ports | 8, 8-bit TTL ports, bit configurable, sink or source 24 mA outputs |
| Open-loop PWM outputs | |
| Number of PWM outputs | 2, 50 kHz |
| Clock sources | Internal or external |

Power Requirements

| | |
|-----------------------------|---------------|
| +3.3 V ($\pm 10\%$) | 2 A |
| +5 V ($\pm 5\%$) | 2 A |
| +12 V ($\pm 5\%$) | 30 mA |
| -12 V ($\pm 10\%$) | 0 mA |
| Power consumption | 18 W, maximum |

Physical

| | |
|---------------------------------------|---------------------------------------|
| Dimensions (not including connectors) | |
| PXI | 16 by 10 cm (6.3 by 3.9 in.) |
| PCI | 17.5 by 9.9 cm (6.9 by 3.9 in.) |
| Connectors | |
| Motion I/O connector | 68-pin female high-density VHDCI type |
| Digital I/O connector | 68-pin female high-density VHDCI type |

Environment

| | |
|-------------------------------|---------------------------|
| Operating temperature | 0 to 55 °C |
| Storage temperature | -20 to 70 °C |
| Relative humidity range | 10 to 90% (noncondensing) |

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integrators. Services range from start-up assistance to turnkey system integration. Visit ni.com/alliance.



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We also offer service programs that provide automatic upgrades to your application development environment and higher levels of technical support. Visit ni.com/ssp.

Hardware Services

NI Factory Installation Services

NI Factory Installation Services (FIS) is the fastest and easiest way to use your PXI or PXI/SCXI combination systems right out of the box. Trained NI technicians install the software and hardware and configure the system to your specifications. NI extends the standard warranty by one year on hardware components (controllers, chassis, modules) purchased with FIS. To use FIS, simply configure your system online with ni.com/pxiadvisor.

Calibration Services

NI recognizes the need to maintain properly calibrated devices for high-accuracy measurements. We provide manual calibration procedures, services to recalibrate your products, and automated calibration software specifically designed for use by metrology laboratories. Visit ni.com/calibration.

Repair and Extended Warranty

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