

Motion Control

NI PCI-7390 User Manual

Worldwide Technical Support and Product Information

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Depending on where it is operated, this Class A product could be subject to restrictions in the FCC rules. (In Canada, the Department of Communications (DOC), of Industry Canada, regulates wireless interference in much the same way.) Digital electronics emit weak signals during normal operation that can affect radio, television, or other wireless products.

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Consult the FCC Web site at www.fcc.gov for more information.

FCC/DOC Warnings

This equipment generates and uses radio frequency energy and, if not installed and used in strict accordance with the instructions in this manual and the CE marking Declaration of Conformity*, may cause interference to radio and television reception. Classification requirements are the same for the Federal Communications Commission (FCC) and the Canadian Department of Communications (DOC).

Changes or modifications not expressly approved by NI could void the user's authority to operate the equipment under the FCC Rules.

Class A

Federal Communications Commission

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user is required to correct the interference at their own expense.

Canadian Department of Communications

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

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Users in the European Union (EU) should refer to the Declaration of Conformity (DoC) for information* pertaining to the CE marking. Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, visit ni.com/certification, search by model number or product line, and click the appropriate link in the Certification column.

* The CE marking Declaration of Conformity contains important supplementary information and instructions for the user or installer.

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About This Manual

This manual describes the electrical and mechanical aspects of the National Instruments PCI-7390 and contains information about how to operate and program the device.

The NI PCI-7390 is designed for PCI bus computers.

Conventions

The following conventions appear in this manual:

<>

Angle brackets that contain numbers separated by an ellipsis represent a range of values associated with a bit or signal name—for example, AO <3..0>.

»

The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.



This icon denotes a tip, which alerts you to advisory information.



This icon denotes a note, which alerts you to important information.



This icon denotes a caution, which advises you of precautions to take to avoid injury, data loss, or a system crash. When this symbol is marked on a product, refer to the *Safety Information* section of Chapter 2, *Configuration and Installation*, for information about precautions to take.

bold

Bold text denotes items that you must select or click in the software, such as menu items and dialog box options. Bold text also denotes parameter names.

italic

Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept. Italic text also denotes text that is a placeholder for a word or value that you must supply.

monospace

Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames, and extensions.

Related Documentation

The following documents contain information you might find helpful as you read this manual:

- *NI PCI-7390 Installation Guide*—Refer to this document for installation instructions.
- *Getting Started with NI-Motion for NI 73xx Motion Controllers*—Refer to this document for general information about the NI-Motion product.
- *Measurement & Automation Explorer Help for Motion*—Refer to this document for configuration information.
- *NI-Motion Function Help*—Refer to this document for specific information about NI-Motion C/C++ functions.
- *NI-Motion VI Help*—Refer to this document for specific information about NI-Motion LabVIEW VIs.
- *NI-Motion User Manual*—Refer to this document for information about the NI-Motion driver software, including background, configuration, and programming information.

Introduction

This chapter includes information about the features of the NI PCI-7390 controller and information about operating the device.

About the PCI-7390 Controller

The PCI-7390 controller features advanced motion control with easy-to-use software tools and add-on motion VI libraries for use with LabVIEW.

Features

The PCI-7390 is a position-command (p-command) stepper motion controller with isolation designed for use with drives that support p-command mode or step (pulse) command input. The PCI-7390 has accessories specifically designed for direct connectivity to Yaskawa Sigma II, Mitsubishi MR-J2S and Panasonic Minus A drives. The PCI-7390 provides fully programmable motion control for up to four independent or coordinated axes of motion, with dedicated motion I/O for limit and home switches and additional I/O for general-purpose functions.

You can use the PCI-7390 controller for point-to-point and straight-line vector moves. The PCI-7390 also performs arbitrary and complex motion trajectories through circular, spherical, or helical interpolation.

Stepper axes can operate in open or closed-loop mode. The PCI-7390 uses quadrature encoders for position and velocity feedback (closed-loop only), and provides advanced encoder functions such as trigger (position capture) and breakpoint (position compare). The PCI-7390 provides step/direction or clockwise (CW)/counter-clockwise (CCW) digital command outputs. The controller supports full, half, and microstepping applications on all four axes.

Hardware

The PCI-7390 is a high performance controller that uses an advanced dual-processor architecture including a 32-bit CPU combined with a digital signal processor (DSP) and a custom field programmable gate array (FPGA). The first-in, first-out (FIFO) bus interface and powerful function set provide high-speed communications while off-loading complex motion functions from the host PC for optimum command throughput and system performance.

The PCI-7390 uses a 100-pin SCSI I/O connector. Each axis of the PCI-7390 has motion I/O for end-of-travel limit and home switch inputs, breakpoint (position compare) output, trigger (position capture) input, inhibit (alarm) input, in-position input, drive (servo) ready input, inhibit (drive enable) output, shutdown input, alarm clear output and encoder feedback. The PCI-7390 also has eight non-dedicated user inputs and eight non-dedicated user outputs.

RTSI

The PCI-7390 supports the National Instruments Real-Time System Integration (RTSI) bus. The RTSI bus provides high-speed connectivity between National Instruments products, including image acquisition and data acquisition products. Using the RTSI bus, you can easily synchronize several functions to a common trigger or timing event across multiple motion, image or data acquisition devices.

What You Need to Get Started

To set up and use the PCI-7390 controller, you must have the following items:

- PCI-7390 motion controller and documentation
- NI-Motion 7.2 or later driver software and documentation
- One of the following software packages and documentation:
 - LabVIEW 7.0 or later
 - LabWindows™/CVI™ 7.0 or later
 - C/C++
 - Microsoft Visual Basic 6.0
- Computer with an available PCI slot
- +24 V external power supply

Software Programming Choices

NI-Motion is a simple but powerful high-level application programming interface (API) that makes programming the PCI-7390 easy. You can execute all setup and motion control functions by calling into a dynamically-linked library (DLL). You can use the full function set implementations for LabVIEW and LabWindows/CVI, or call the NI-Motion libraries from C and Visual Basic.

National Instruments Application Software

LabVIEW is based on the graphical programming language, G, and features interactive graphics and a state-of-the-art user interface. In LabVIEW, you can create 32-bit compiled programs and stand-alone executables for custom automation, data acquisition, test, measurement, and control solutions. National Instruments offers the NI-Motion VI Library, which is a series of virtual instruments (VIs) for using LabVIEW with National Instruments motion control hardware. The NI-Motion VI library implements the full API, along with a useful set of example programs.

ANSI C-based LabWindows/CVI also features interactive graphics and a state-of-the-art user interface. Using LabWindows/CVI, you can generate C code for custom data acquisition, test, and measurement and automation solutions. The NI-Motion software includes a series of example programs for using LabWindows/CVI with National Instruments motion control hardware.

NI Motion Assistant offers a point-and-click interface for creating motion control sequences quickly and easily. When you have created a motion task, you can use Motion Assistant to output the task in LabVIEW or C code or code recipes.

Optional Equipment

National Instruments offers a variety of products for use with the PCI-7390 controller, including the following accessories:

- Cables and cable assemblies for motion and digital I/O
- RTSI cable for connection with other National Instruments devices
- Connector blocks and shielded and unshielded 100-pin screw terminal wiring aids
- Motion Connection Accessory (MCA) wiring connectivity blocks for easy and direct connections to Mitsubishi (NI part number 779612-01), Panasonic (NI part number 779613-01), and Yaskawa (NI part number 779611-01) drives. Refer to Appendix B, [Motion Connection Accessories](#), for more information.
- +24 V DC power supplies
 - PS-4 (NI part number 778586-90)
 - PS-5 (NI part number 778805-90)

For more specific information about these products, refer to the National Instruments catalog, the National Instruments Web site at ni.com, or call your National Instruments sales representative.

Configuration and Installation

This chapter describes how to configure and install the NI PCI-7390.

Software Installation

Before installing the PCI-7390, install the NI-Motion driver software and, if appropriate, the NI-Motion VI libraries. For specific installation instructions refer to the *NI PCI-7390 Installation Guide*, which is included with the controller, or to *Getting Started with NI-Motion for NI 73xx Motion Controllers*, which is installed in the NI-Motion/Documentation folder where you installed NI-Motion. The default directory is Program Files\National Instruments\NI-Motion.



Note If you do not install the NI-Motion driver software before attempting to use the PCI-7390, the system will not recognize the PCI-7390 and you will be unable to configure or use the device.

Controller Configuration

Because motion I/O-related configuration of the PCI-7390 is performed entirely with software, it is not necessary to set jumpers for motion I/O configuration. However, it is necessary to set jumpers to select between sinking or sourcing output type for the controller's general-purpose outputs. Refer to the [Selecting Sinking or Sourcing General-Purpose Outputs](#) section of Chapter 4, *Signal Connections*, for more information.

The PCI-7390 controller is fully compatible with the industry standard *PCI Local Bus Specification*, Revision 2.2. This compatibility allows the PCI system to automatically perform all bus-related configuration without user interaction. It is not necessary to configure jumpers for bus-related configuration, including setting the device base memory and interrupt channel.



Note When adding or removing a controller from a Windows 2000/XP system, you must be logged on with administrator-level access. After you have restarted the system, you may need to refresh Measurement & Automation Explorer (MAX) to view the new controller.

Safety Information



Caution The following section contains important safety information that you *must* follow when installing and using the PCI-7390.

Do *not* operate the device in a manner not specified in this document. Misuse of the device can result in a hazard. You can compromise the safety protection built into the device if the device is damaged in any way. If the device is damaged, return it to National Instruments (NI) for repair.

Do *not* substitute parts or modify the device except as described in this document. Use the device only with the chassis, modules, accessories, and cables specified in the installation instructions. You *must* have all covers and filler panels installed during operation of the device.

Do *not* operate the device in an explosive atmosphere or where there may be flammable gases or fumes. If you must operate the device in such an environment, it must be in a suitably rated enclosure.

If you need to clean the device, use a soft, nonmetallic brush. Make sure that the device is completely dry and free from contaminants before returning it to service.

Operate the device only at or below Pollution Degree 2. Pollution is foreign matter in a solid, liquid, or gaseous state that can reduce dielectric strength or surface resistivity. The following is a description of pollution degrees:

- Pollution Degree 1 means no pollution or only dry, nonconductive pollution occurs. The pollution has no influence.
- Pollution Degree 2 means that only nonconductive pollution occurs in most cases. Occasionally, however, a temporary conductivity caused by condensation must be expected.
- Pollution Degree 3 means that conductive pollution occurs, or dry, nonconductive pollution occurs that becomes conductive due to condensation.



Note The PCI-7390 is intended for indoor use only.

You *must* insulate signal connections for the maximum voltage for which the device is rated. Do *not* exceed the maximum ratings for the device. Do not install wiring while the device is live with electrical signals. Do not remove or add connector blocks when power is connected to the system.

Remove power from signal lines before connecting them to or disconnecting them from the device.

Operate the device at or below the measurement category¹ marked on the hardware label. Measurement circuits are subjected to *working voltages*² and transient stresses (overvoltage) from the circuit to which they are connected during measurement or test. Installation categories establish standard impulse withstand voltage levels that commonly occur in electrical distribution systems. The following is a description of installation categories:

- Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as MAINS³ voltage. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.
- Measurement Category II is for measurements performed on circuits directly connected to the electrical distribution system. This category refers to local-level electrical distribution, such as that provided by a standard wall outlet (for example, 115 AC voltage for U.S. or 230 AC voltage for Europe). Examples of Installation Category II are measurements performed on household appliances, portable tools, and similar devices/modules.
- Measurement Category III is for measurements performed in the building installation at the distribution level. This category refers to measurements on hard-wired equipment such as equipment in fixed installations, distribution boards, and circuit breakers. Other examples are wiring, including cables, bus bars, junction boxes, switches, socket outlets in the fixed installation, and stationary motors with permanent connections to fixed installations.
- Measurement Category IV is for measurements performed at the primary electrical supply installation (<1,000 V). Examples include electricity meters and measurements on primary overcurrent protection devices and on ripple control units.

¹ Measurement categories, also referred to as *installation categories*, are defined in electrical safety standard IEC 61010-1.

² Working voltage is the highest rms value of an AC or DC voltage that can occur across any particular insulation.

³ MAINS is defined as a hazardous live electrical supply system that powers equipment. Suitably rated measuring circuits may be connected to the MAINS for measuring purposes.

Hardware Installation

Install the PCI-7390 in any open PCI slot in the computer. Appendix A, [Specifications](#), lists typical power requirements for the PCI-7390 controller.

The following instructions are for general installation. Consult the computer user manual or technical reference manual for specific instructions and warnings.



Caution The PCI-7390 is a sensitive electronic device shipped in an antistatic bag. Open only at an approved workstation and observe precautions for handling electrostatic-sensitive devices.

1. Power off and unplug the computer.



Caution To protect yourself and the computer from electrical hazards, the computer must remain unplugged until the installation is complete.

2. Open the computer case to expose access to the PCI expansion slots.
3. Choose an unused +3.3 V or +5 V PCI slot, and remove the corresponding expansion slot cover on the back panel of the computer.



Caution Do *not* insert or remove any PCI-7390 motion controller from your system without first disconnecting the +24 V power supplies from all PCI-7390 devices. Failure to do so may result in damage to your system and/or PCI-7390.

4. Touch a metal part on the computer case to discharge any static electricity that might be on your clothes or body before handling the controller. Static electricity can damage the controller.
5. Gently rock the controller into the slot. The connection may be tight, but do *not* force the controller into place.
6. If required, screw the mounting bracket of the controller to the back panel rail of the computer.
7. Replace the cover.



Caution Make sure you have correctly connected all safety devices before you power on the motion system. Safety devices include inhibits, limit switches, and emergency shut down circuits.



Caution Always power on the computer containing the PCI-7390, then the +24 V external power supply, then initialize the controller before you power on the rest of the motion system. Power off in the reverse order.

8. Plug in and power on the computer, then the +24 V external power supply.
9. Initialize the controller.



Note When adding or removing a controller from a Windows 2000/XP system, you must be logged on with administrator-level access. After you have restarted the system, you may need to refresh MAX to view the new controller.

Hardware Overview

This chapter presents an overview of the NI PCI-7390 functionality and capabilities.

Figures 3-1 and 3-2 illustrate the functional components of the PCI-7390.

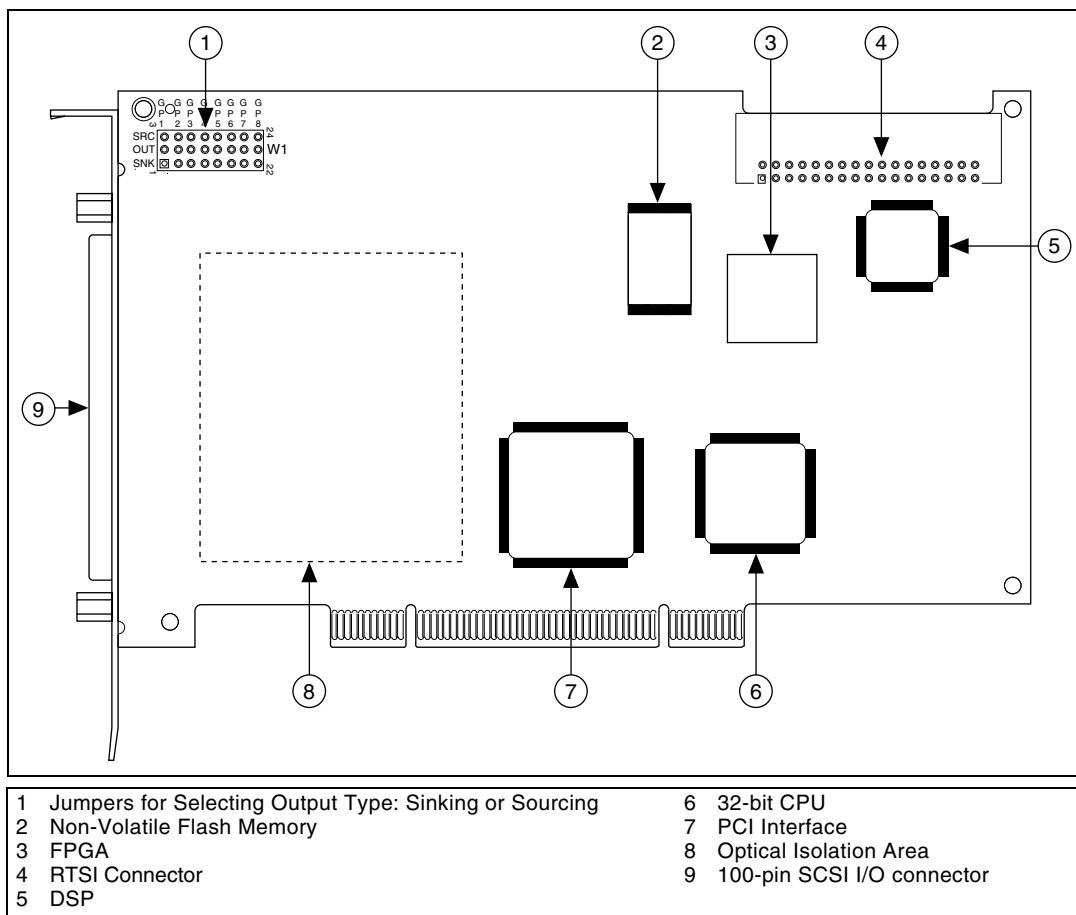


Figure 3-1. PCI-7390 Parts Locator Diagram (Front)

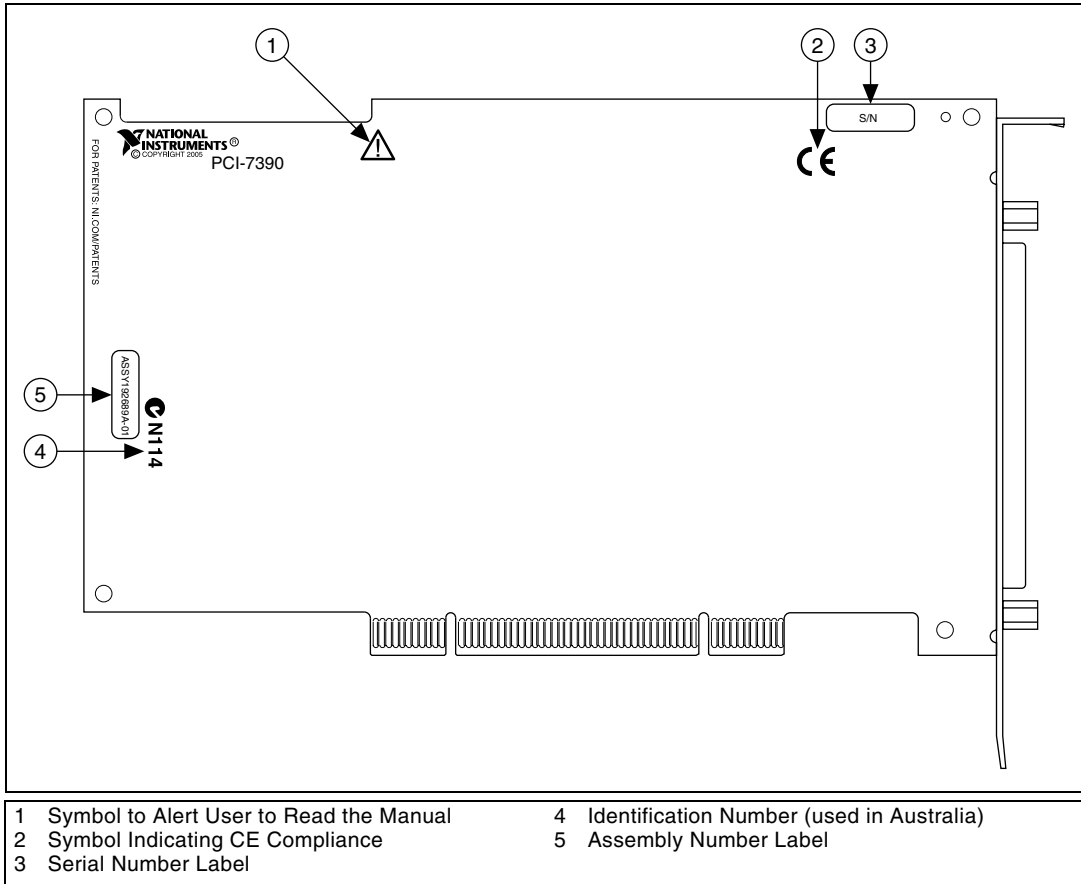


Figure 3-2. PCI-7390 Parts Locator Diagram (Back)

User Connectors

The 100-pin SCSI I/O connector provides all the signals for four axes of closed-loop motion control, including encoder feedback, limit and home inputs, breakpoint (position compare) outputs, trigger (position capture) input, inhibit (alarm) inputs, and in-position inputs. The connector also can provide shutdown (emergency stop) input, drive (servo) ready inputs, inhibit (drive enable) outputs, alarm clear outputs, and general-purpose inputs and outputs. All inputs and outputs are optically isolated. Refer to Chapter 4, *Signal Connections*, for details about the I/O connector signals.

The PCI-7390 RTSI connector provides up to eight triggers to facilitate synchronization between multiple National Instruments products. Typical applications of the RTSI bus include triggering an image acquisition or DAQ measurement based on motion events, or capturing current motion positions based on events external to the motion controller. You also can use the RTSI bus for general hardware-based communication between RTSI devices.

The RTSI bus also can be used for general-purpose I/O. Refer to Chapter 4, [Signal Connections](#), for details about RTSI connector signals.

Functional Overview

This section provides an overview of the PCI-7390 capabilities, including the advanced dual-processor architecture, axes and motion resources, and communication with the host computer.

Dual Processor Architecture

The PCI-7390 can perform up to four axes of simultaneous motion control in a preemptive, multitasking, real-time environment.

An advanced dual-processor architecture that uses a real-time 32-bit CPU combined with a DSP and a custom FPGA give the PCI-7390 controllers high-performance capabilities. The FIFO bus interface and powerful function set provide high-speed communications while off-loading complex motion functions from the host PC for optimized system performance.

The PCI-7390 uses the DSP for all closed-loop control and motion trajectory generation. The DSP chip is supported by a custom FPGA that performs the high-speed encoder interfacing, trigger (position capture) and breakpoint (position compare) functions, motion I/O processing, and stepper pulse generation for hard real-time functionality.

The embedded CPU runs a multitasking, real-time operating system and handles host communications, command processing, multi-axis interpolation, error handling, general-purpose digital I/O, and overall motion system integration functions.

Embedded Real-Time Operating System

The embedded firmware is based upon an embedded real-time operating system (RTOS) kernel and provides optimum system performance in varying motion applications. Motion tasks are prioritized. Task execution order depends on the priority of each task, the state of the entire motion system, I/O or other system events, and the real-time clock.

The DSP chip is a separate processor that operates independently from the CPU but is closely synchronized. The PCI-7390 is a true multiprocessing and multitasking embedded controller.

Refer to the *NI-Motion User Manual* for more information about the features available on the PCI-7390.

Trajectory Generators

The PCI-7390 controller trajectory generators calculate the instantaneous position command that controls acceleration and velocity while it moves the axis to its target position. This command is then sent to the stepper pulse generator.

To implement infinite trajectory control, the PCI-7390 controller has eight trajectory generators implemented in the DSP chip (two per axis). Each generator calculates an instantaneous position for each update period. While simple point-to-point moves require only one trajectory generator, two simultaneous generators are required for blended moves and infinite trajectory control processing.

Flash Memory

Nonvolatile memory on the PCI-7390 controller is implemented with flash ROM, which means that the controllers can electrically erase and reprogram their own ROM. Because all embedded firmware, including the RTOS, DSP code, and the FPGA configuration file of the PCI-7390 is stored in flash memory, you can upgrade the onboard firmware contents in the field for support and new-feature enhancement.

It is possible to save the entire parameter state of the controller to the flash memory. On the next power cycle, the controller automatically loads and returns the configuration to these new saved default values.

Use MAX to download new firmware or save configuration defaults to flash memory.

A flash memory download utility is included with the NI-Motion software that ships with the controller.

Axes and Motion Resources

The PCI-7390 controller can control up to four axes of motion. The axes can be completely independent, simultaneously coordinated, or mapped in multidimensional groups called coordinate spaces. You also can simultaneously start coordinate spaces for multi-vector space coordinated motion control.

Axes

At a minimum, an axis consists of a trajectory generator, a stepper control block, and a stepper pulse generator output. Closed-loop stepper axes require a feedback resource, while open-loop stepper axes do not. Figure 3-3 shows this axis configuration.

With the PCI-7390 controller, you can map one feedback resource and one or two output resources to the axis.

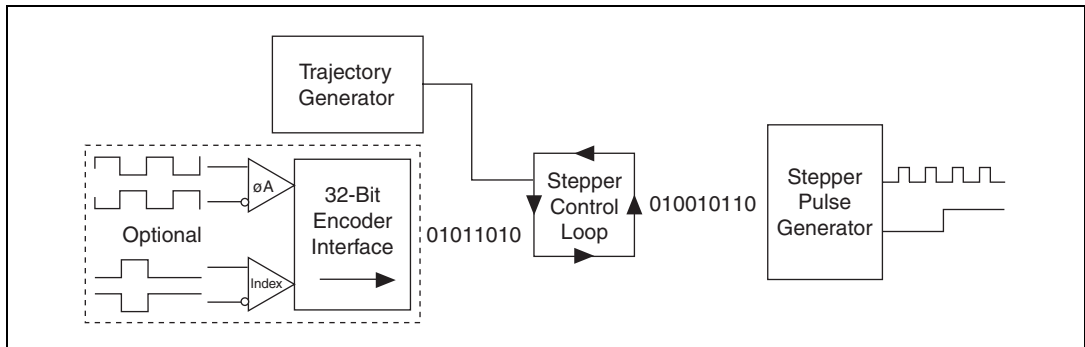


Figure 3-3. Stepper Axis Resources

The PCI-7390 supports axes with secondary output resources. Defining two output resources is useful when controlling axes with multiple motors.



Note Refer to the *NI-Motion User Manual* for more information about configuring axes.

Motion Resources

Encoder and motion I/O resources that are not used by an axis are available for non-axis or non-motion-specific applications.

If an encoder resource is not needed for axis control, you can use it for any number of other functions, including position or velocity monitoring, as a digital potentiometer encoder input, or as a master encoder input for master/slave (electronic gearing) applications.

Each axis also has an associated forward and reverse limit input, a home input, inhibit (alarm) input and in-position input, a high-speed capture trigger (position capture) input, and a breakpoint (position compare) output. Each axis also has a configurable drive (servo) ready input, inhibit output, and alarm clear output. One shutdown input for the controller is also available. These signals can be used for general-purpose digital I/O when they are not being used for their motion-specific purpose.



Note When a resource is mapped to an axis, all features and functions of the resource are available as part of the axis. Because resources are referenced by axis number after they are assigned to that axis, it is not necessary to remember or use the resource number directly when accessing these features.

Host Communications

The host computer communicates with the controller through a number of memory port addresses on the host PCI bus.

The primary bidirectional data transfer port supports FIFO data passing in both send and readback directions. The PCI-7390 controller has both a command buffer for incoming commands and a return data buffer for returning data.

The communications status register provides bits for communications handshaking as well as real-time error reporting and general status feedback to the host PC. The move complete status register provides instantaneous motion status of all axes.

Signal Connections

This chapter includes instructions on how to make input and output signal connections directly to the NI PCI-7390 controller and briefly describes the associated I/O circuitry.

The PCI-7390 has two connectors that handle all signals to and from the external motion system:

- 100-pin SCSI I/O connector
- RTSI connector

You can connect to your motion system with cables and accessories, varying from simple screw terminal blocks to enhanced drive-specific Motion Connection Accessory (MCA) units. Refer to Appendix B, *Signal Connections*, for more information about the MCA units.



Caution Do *not* connect or disconnect the PCI-7390 controller I/O cable without first disconnecting the +24 V power supply from all PCI-7390 boards. Failure to do so may result in damage to your system and/or PCI-7390 motion controller.

I/O Connector

The I/O connector contains optically isolated motion control signals and general-purpose signals, including the following features:

- Motor command stepper outputs
- Forward, home, and reverse limit inputs
- Inhibit-in (alarm) inputs
- In-position inputs
- Encoder feedback inputs
- Trigger (position capture) inputs
- Breakpoint (position compare) outputs
- General-purpose inputs
 - Drive (servo) ready inputs
 - Shutdown input

- General-purpose outputs
 - Inhibit-out (drive enable) outputs
 - Alarm clear outputs

You can configure the general-purpose inputs and outputs in software for optional functionality such as drive ready inputs and alarm clear outputs. Figure 4-1 shows the pin assignments for the 100-pin motion I/O connector on the PCI-7390.

Isolated +5V OUT	50	100	Isolated +5V OUT
Isolated Ground	49	99	Isolated Ground
+24V IN	48	98	Axis 2 General-Purpose Output 0
General-Purpose Output Supply	47	97	Axis 3 General-Purpose Output 0
Axis 1 General-Purpose Output 0	46	96	Axis 4 General-Purpose Output 0
Axis 1 General-Purpose Output 1/Axis 1 Inhibit-Out*	45	95	Axis 3 General-Purpose Output 1/Axis 3 Inhibit-Out*
Axis 1 Encoder Phase A +	44	94	Axis 3 Encoder Phase A +
Axis 1 Encoder Phase A -	43	93	Axis 3 Encoder Phase A -
Axis 1 Encoder Phase B +	42	92	Axis 3 Encoder Phase B +
Axis 1 Encoder Phase B -	41	91	Axis 3 Encoder Phase B -
Axis 1 Index (Encoder Phase Z) +	40	90	Axis 3 Index (Encoder Phase Z) +
Axis 1 Index (Encoder Phase Z) -	39	89	Axis 3 Index (Encoder Phase Z) -
Isolated Ground	38	88	Isolated Ground
Axis 1 Step (CW) +	37	87	Axis 3 Step (CW) +
Axis 1 Step (CW) -	36	86	Axis 3 Step (CW) -
Axis 1 Dir (CCW) +	35	85	Axis 3 Dir (CCW) +
Axis 1 Dir (CCW) -	34	84	Axis 3 Dir (CCW) -
Axis 1 Breakpoint (Position Compare)	33	83	Axis 3 Breakpoint (Position Compare)
Axis 1 VL_COM	32	82	Axis 3 VI_COM
Axis 1 Trigger (Position Capture)	31	81	Axis 3 Trigger (Position Capture)
Axis 1 Forward Limit Switch	30	80	Axis 3 Forward Limit Switch
Axis 1 Reverse Limit Switch	29	79	Axis 3 Reverse Limit Switch
Axis 1 Home Switch	28	78	Axis 3 Home Switch
Axis 1 Inhibit-In (Alarm)	27	77	Axis 3 Inhibit-In (Alarm)
Axis 1 In-Position	26	76	Axis 3 In-Position
Axis 1 General-Purpose Input 0	25	75	Axis 3 General-Purpose Input 0
Axis 1 General-Purpose Input 1*/Axis 4 Drive (Servo) Ready	24	74	Axis 3 General-Purpose Input 1*/Axis 4 Drive (Servo) Ready
Isolated Ground	23	73	Isolated Ground
Axis 2 General-Purpose Output 1/Axis 2 Inhibit-Out*	22	72	Axis 4 General-Purpose Output 1/Axis 4 Inhibit-Out*
Axis 2 Encoder Phase A +	21	71	Axis 4 Encoder Phase A +
Axis 2 Encoder Phase A -	20	70	Axis 4 Encoder Phase A -
Axis 2 Encoder Phase B +	19	69	Axis 4 Encoder Phase B +
Axis 2 Encoder Phase B -	18	68	Axis 4 Encoder Phase B -
Axis 2 Index (Encoder Phase Z) +	17	67	Axis 4 Index (Encoder Phase Z) +
Axis 2 Index (Encoder Phase Z) -	16	66	Axis 4 Index (Encoder Phase Z) -
Isolated Ground	15	65	Isolated Ground
Axis 2 Step (CW) +	14	64	Axis 4 Step (CW) +
Axis 2 Step (CW) -	13	63	Axis 4 Step (CW) -
Axis 2 Dir (CCW) +	12	62	Axis 4 Dir (CCW) +
Axis 2 Dir (CCW) -	11	61	Axis 4 Dir (CCW) -
Axis 2 Breakpoint (Position Compare)	10	60	Axis 4 Breakpoint (Position Compare)
Axis 2 VL_COM	9	59	Axis 4 VI_COM
Axis 2 Trigger (Position Capture)	8	58	Axis 4 Trigger (Position Capture)
Axis 2 Forward Limit Switch	7	57	Axis 4 Forward Limit Switch
Axis 2 Reverse Limit Switch	6	56	Axis 4 Reverse Limit Switch
Axis 2 Home Switch	5	55	Axis 4 Home Switch
Axis 2 Inhibit-In (Alarm)	4	54	Axis 4 Inhibit-In (Alarm)
Axis 2 In-Position	3	53	Axis 4 In-Position
Axis 2 General-Purpose Input 0	2	52	Axis 4 General-Purpose Input 0
Axis 2 General-Purpose Input 1*/Axis 4 Drive (Servo) Ready	1	51	Axis 4 General-Purpose Input 1*/Axis 4 Drive (Servo) Ready

Figure 4-1. 100-Pin I/O Connector Pin Assignments



Note An asterisk (*) on the signal name indicates the software default signal for the pin.

Table 4-1 includes descriptions for each of the signals and alternate signal names.

Table 4-1. I/O Signal Connections

Signal Name	Alternate Signal Name	Reference	Direction	Description
Axis <1..4> Dir (CCW) ±	—	Isolated Ground	Output	Motor direction or counter-clockwise control
Axis <1..4> Step (CW) ±	Pulse	Isolated Ground	Output	Motor step or clockwise control
Axis <1..4> Encoder Phase A ±	—	—	Input	Phase A encoder input
Axis <1..4> Encoder Phase B ±	—	—	Input	Phase B encoder input
Axis <1..4> Index (Encoder Phase Z) ±	Encoder Phase Z	—	Input	Index encoder input
Axis <1..4> Inhibit-In	Alarm, Drive-Fault	VI_COM <1..4>	Input	Inhibit input—alarm or fault signal from the drive
Axis <1..4> In-Position	—	VI_COM <1..4>	Input	Move complete status signal from the drive
Axis <1..4> Home Switch	—	VI_COM <1..4>	Input	Home switch
Axis <1..4> Forward Limit Switch	—	VI_COM <1..4>	Input	Forward/clockwise limit switch
Axis <1..4> Reverse Limit Switch	—	VI_COM <1..4>	Input	Reverse/counter-clockwise limit switch
Axis <1..4> Trigger (Position Capture)	Position Capture	Isolated Ground	Input	High-speed position capture input
Axis <1..4> Breakpoint (Position Compare)	Position Compare	Isolated Ground	Output	High-speed position compare output
Axis <1..4> General-Purpose Input <0..1>	—	VI_COM <1..4>	Input	General-purpose inputs
Optional general-purpose input functionality Axis <1..4> Drive (Servo) Ready	Drive Ready, Servo Ready	VI_COM <1..4>	Input	Signal from the drive indicating the drive is ready
Optional general-purpose input functionality Shutdown	Emergency stop	Isolated Ground	Input	Signal from an emergency stop switch that causes the controller to enter a reset state

Table 4-1. I/O Signal Connections (Continued)

Signal Name	Alternate Signal Name	Reference	Direction	Description
Axis <1..4> General-Purpose Output <0..1>	—	Isolated Ground	Output	General-purpose outputs
Optional general-purpose output functionality Axis <1..4> Inhibit-Out	Servo ON, Drive Enable	Isolated Ground	Output	Drive inhibit
Optional general-purpose output functionality Axis <1..4> Alarm Clear	Servo Alarm Clear	Isolated Ground	Output	Clears an alarm output from the drive
Isolated +5 V OUT	—	Isolated Ground	Output	Isolated +5 V power supply output generated from the +24 V IN power supply
Isolated Ground	—	—	—	Reference for all outputs, trigger inputs, +24 V IN and Isolated +5 V OUT
General-Purpose Output Supply	—	Isolated Ground	Input	Positive supply/reference for general-purpose outputs.
Axis <1..4> VI_COM	—	—	—	Reference for the following Axis <1..4> inputs: Forward and Reverse Limits, Home, Inhibit-In, Input Bit <1..2>
+24 V IN	—	Isolated Ground	Input	+24 V supply provided by the user to power optical isolation circuitry

Power Supply Connections

The PCI-7390 requires an external +24 V power supply for the optical isolation circuitry. An onboard regulator generates a +5 V output supply for both internal and external usage. Figure 4-2 shows a simplified schematic of the power supply connections. The positive terminal for the +24 V supply must be connected to +24 V IN and the reference must be connected to Isolated Ground.

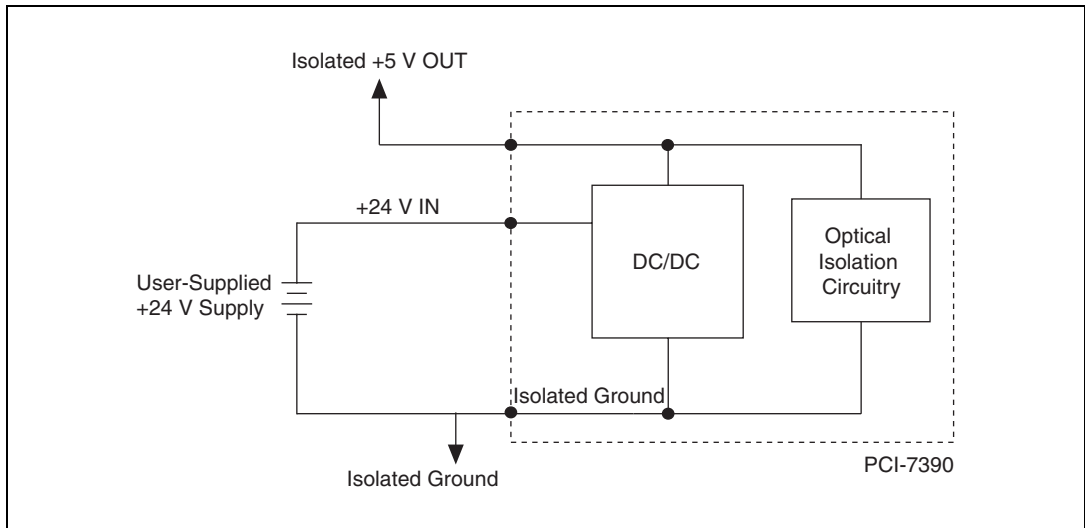


Figure 4-2. Power Supply Connections

Step and Direction Outputs

- **Axis <1..4> Step (CW) \pm and Dir (CCW) \pm** —These RS-422 differential signals are the stepper command outputs for each axis. The PCI-7390 supports both major industry standards for stepper command signals: step and direction, or independent clockwise (CW) and counter-clockwise (CCW) pulse outputs.

The output configuration and signal polarity is software programmable for compatibility with various third-party drives, as follows:

- When step and direction mode is configured, each commanded step (or microstep) produces a pulse on the step output. The direction output signal level indicates the command direction of motion, either forward or reverse.
- CW and CCW mode produces pulses (steps) on the CW output for forward-commanded motion and pulses on the CCW output for reverse-commanded motion.

In either case, you can set the polarity of both outputs to active low or active high. For example, with step and direction, you can make a logic high correspond to either forward or reverse direction.

Step and Direction Output Circuit

The Step (CW) and Dir (CCW) outputs are driven by high-speed RS-422 line drivers that feature 20 mA drive capability.



Caution Do *not* connect these outputs to anything other than a +5 V circuit. The output buffers will fail if subjected to voltages in excess of +5.5 V.

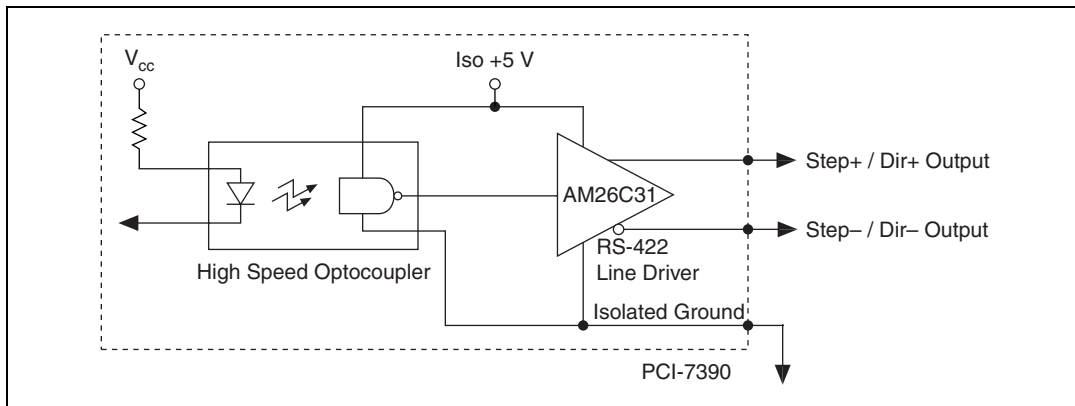


Figure 4-3. Step and Direction Output Circuit

Limit and Home Inputs

- Axis <1..4> Forward Limit Input
- Axis <1..4> Home Input
- Axis <1..4> Reverse Limit Input

These inputs are optically isolated sinking or sourcing inputs that are typically connected to limit switches located at physical ends of travel and/or at a specific home position. You can use software to enable and disable limit and home inputs at any time. When enabled, an active limit or home input causes a full torque halt stop of the associated motor axis. In addition, an active forward or reverse limit input impedes future commanded motion in that direction for as long as the signal is active.

By default, limit and home inputs are digitally filtered and must remain active for at least 1 ms to be recognized. Refer to Appendix A, [Specifications](#), for more information. You can use MAX to disable digital filtering for limit and home inputs. Active signals should remain active to prevent motion from proceeding further into the limit. Pulsed limit signals

stop motion, but they do not prevent further motion in that direction if another move is started.

Refer to the [Connecting Inputs to the PCI-7390](#) section for detailed information about connecting limit and home inputs. You can use software disabled limit and home inputs as general-purpose inputs. You can read the status of these inputs at any time and change their active state as required.

Limit and home inputs are a per-axis enhancement on the PCI-7390 controller and are not required for basic motion control. These inputs are part of a system solution for complete motion control.



Caution National Instruments recommends using limits for personal safety, as well as to protect the motion system.

Wiring Concerns

For the end of travel limits to function correctly, the forward limit must be located at the forward or positive end of travel, and the reverse limit at the negative end of travel.



Caution Failure to follow these guidelines may result in motion that stops at, but then travels through, a limit, potentially damaging the motion system. Incorrectly wired limits may prevent motion from occurring at all.

Keep limit and home switch signals and their ground connections wired separately from the motor signals.

Inhibit-In (Alarm) and In-Position Inputs

- Axis <1..4> Inhibit-In (Alarm) Input
- Axis <1..4> In-Position Input

These inputs are driven from the p-command drive to provide system status to the controller. The inhibit-in input can be connected to the alarm or servo alarm output of the drive. The alarm signal is inactive during normal operation. When a drive error occurs, the drive is disabled or inhibited using the inhibit-out output. The controller does not generate step and direction outputs when inhibit-in is active. The in-position input can be connected to the in-position output on the drive. It is a feedback signal from the drive indicating that the drive has completed the move and has reached the target position.

Refer to the [Connecting Inputs to the PCI-7390](#) section for detailed information about connecting inhibit-in and in-position inputs. You can use software disabled inhibit-in (alarm) and in-position inputs as general-purpose inputs. You can read the status of these inputs at any time and change their active state as required.

Inhibit-in (alarm) and in-position inputs are a per axis enhancement on the PCI-7390 controller and are not required for basic motion control. These inputs are part of a system solution for complete motion control.

Encoder Inputs

The PCI-7390 offers four channels of quadrature encoder inputs. Each channel consists of differential Phase A, Phase B, and Index (Phase Z) inputs, as described in the following sections. The encoder inputs are optically isolated, differential and RS-422 compatible. The encoder input interface circuit converts the differential inputs to single-ended signals as shown in Figures 4-7 and 4-8. The encoder signals are used for position and velocity feedback for absolute and relative positioning of axes. You can accommodate encoders with various phase relationships by swapping the signals as required by the application.



Note The PCI-7390 does *not* support single-ended encoders.

Figure 4-4 shows the differential encoder input signals and the resulting single-ended signal for Phase A. Phases B and Index are converted in the same way as Phase A.

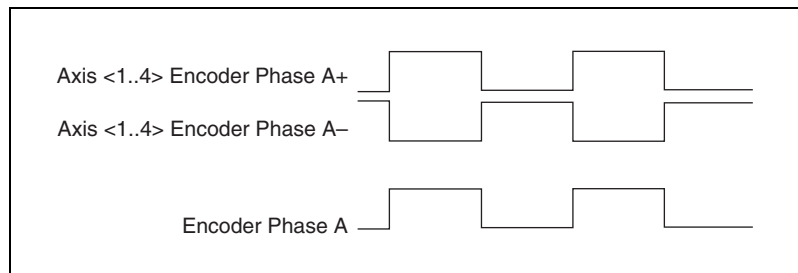


Figure 4-4. Differential to Single-Ended Encoder Signal for Phase A

Axis <1..4> Encoder Phase A and Phase B

The encoder inputs provide position and velocity feedback for absolute and relative positioning of axes in any motion system configuration.

If an encoder resource is not needed for axis control, it is available for other functions, including position or velocity monitoring, digital potentiometer encoder inputs, or as a master encoder input for master/slave (electronic gearing) applications.

The encoder channels (Axis <1..4> Encoder) are implemented in an FPGA and provide advanced features, such as high-speed trigger (position capture) inputs and breakpoint (position compare) outputs. The encoders have a maximum count frequency of 4 MHz.

An encoder input channel converts quadrature signals on Phase A and Phase B into 32-bit up/down counter values. Quadrature signals are generated by optical, magnetic, laser, or electronic devices that provide two signals, Phase A and Phase B, that are 90° out of phase. The leading phase, A or B, determines the direction of motion. The four transition states of the relative signal phases provide distinct pulse edges that cause count up or count down pulses in the direction determined by the leading phase.

A typical encoder with a specification of N (N = number) lines or periods per unit of measure, which can be revolutions or linear distance, produces $4 \times N$ quadrature counts per unit of measure. The count is the basic increment of position in NI-Motion systems.



Tip If your encoder does not supply resolution in quadrature counts per revolution, determine quadrature counts per revolution by multiplying the encoder resolution in encoder lines or periods by four. Encoder counts per revolution is also referred to as counts per index. For example, a 500 line encoder has 2,000 quadrature counts per revolution.

Axis <1..4> Encoder Index (Phase Z)

The Index (Phase Z) input is primarily used to establish a reference position. This function uses the number of counts per revolution or the linear distance to initiate a search move that locates the index position. When a valid Index signal transition occurs during a Find Reference routine, the position of the Index signal is captured accurately. Use this captured position to establish a reference zero position for absolute position control or any other motion system position reference required.

The default MAX settings guarantee that the Find Index routine completes successfully if the encoder generates a high index pulse when phases A and B are low and the encoder is connected through an NI MCA or drive accessory. Figure 4-5 shows the single-ended representation of the connector signals.

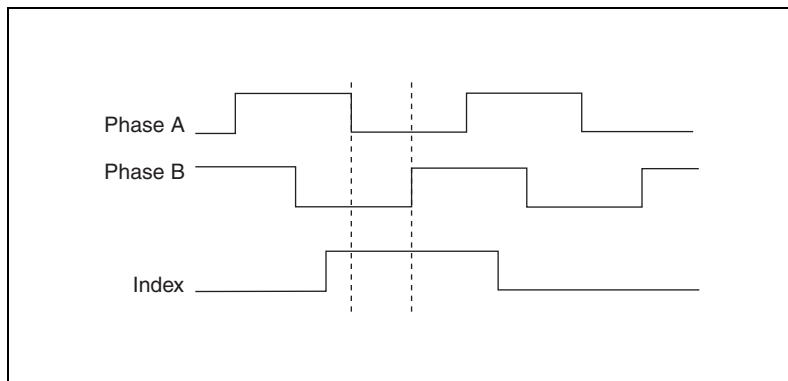


Figure 4-5. Quadrature Encoder Phasing Diagram

You can set the index reference criteria in MAX to change the pattern of phases A and B for the index search. You also can set the encoder polarity for phases A, B, and Z in MAX.

Encoders with differential line driver outputs are strongly recommended for all applications and must be used if the encoder cable length is longer than 3.05 m (10 ft). Cables with twisted pairs and an overall shield are recommended for optimized noise immunity.



Caution Unshielded cables can cause noise to corrupt the encoder signals, resulting in lost counts and reduced motion system accuracy.

Encoder Input Circuit

The PCI-7390 provides optically isolated, RS-422 compatible differential encoder inputs. Figure 4-6 shows a simplified schematic diagram of the encoder input interface circuit. You can connect these inputs to RS-422 driver outputs or to single-ended sourcing or sinking outputs that meet the voltage and current requirements. Figures 4-7 and 4-8 show the connections to devices with sinking outputs and sourcing outputs, respectively. Both phases A and B are required for proper encoder counter operation. The encoder and Index (Phase Z) signals are conditioned by a software-programmable digital filter inside the FPGA. The Index (Phase Z) signal is optional but highly recommended in combination with Find Reference moves for more accurate positioning.

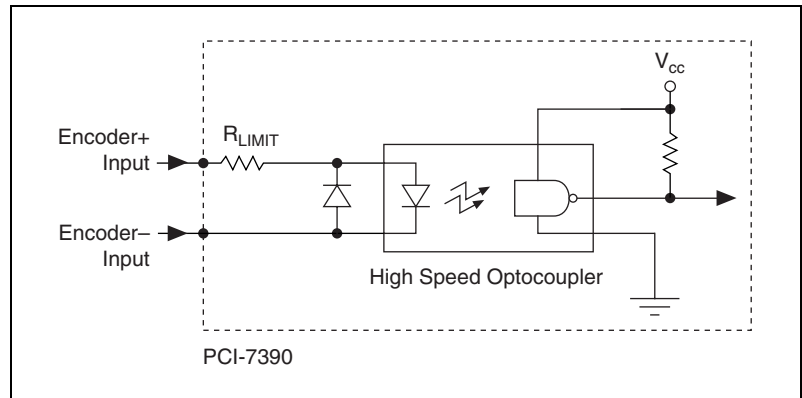


Figure 4-6. Encoder Input Circuit

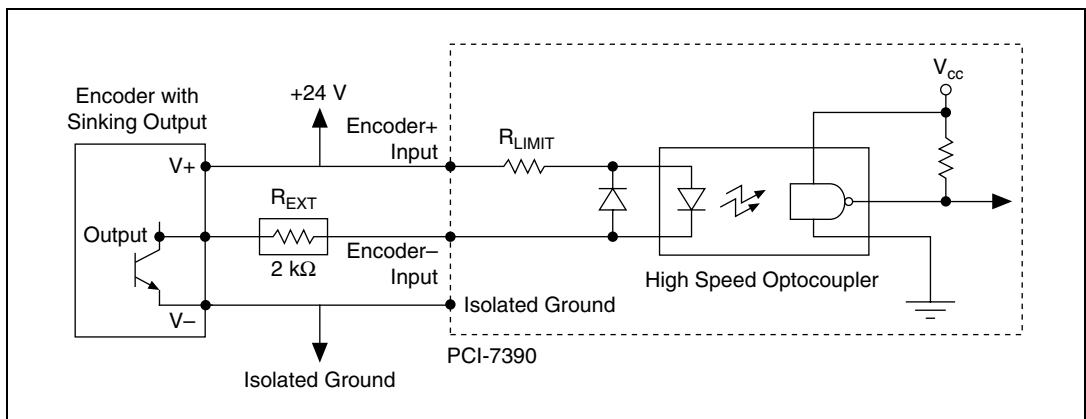


Figure 4-7. Encoder Input Circuit Connected to a Sinking Output Device with a +24 V Power Supply

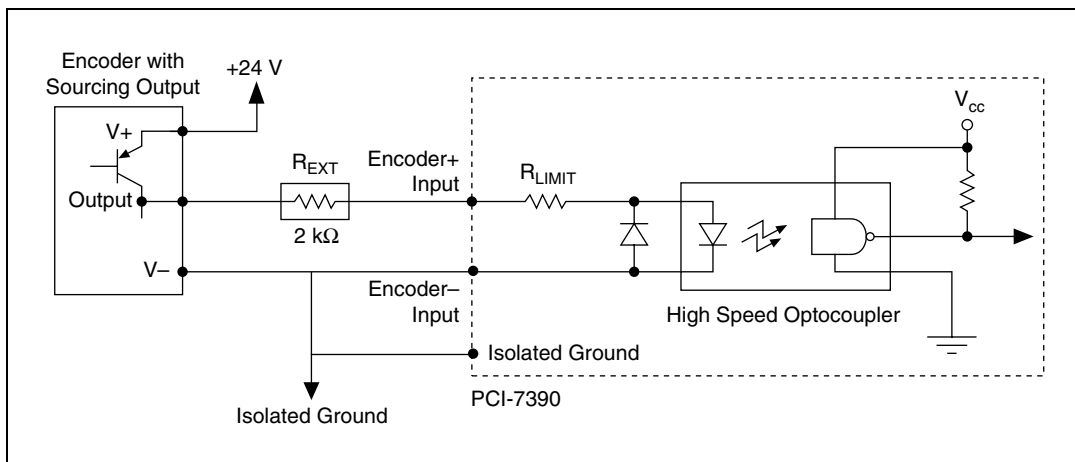


Figure 4-8. Encoder Input Circuit Connected to a Sourcing Output Device with a +24 V Power Supply

Connections for Input Voltages Higher Than 5 V

When connecting to devices with output voltages higher than 5 V, an external resistor (R_{EXT}) must be included.



Note Use a resistor tolerance of 5% or better for R_{EXT} .



Caution Failure to include the resistor with the specified resistance will permanently damage the encoder input circuit.

The required external resistor value is calculated using the following equation:

$$R_{EXT} = [100(\Delta V) - 480]\Omega$$

where

$$\Delta V = V^+ - V^-$$

Refer to Table 4-2 for the R_{EXT} resistance values for the most common voltages.

Table 4-2. Resistance Values for Encoder Connections

Voltage (V)	Typical Resistance (k Ω)	Minimum Resistance (k Ω)	Maximum Resistance (k Ω)
+5	0	—	—
+24	2	1.5	2.5
+12	0.72	0.65	1.2

Wiring Concerns



Caution The encoder input circuit is designed to tolerate 5 V signals. For voltages higher than 5 V, you *must* connect an external resistor to avoid damage to the encoder.

The encoder inputs are connected to quadrature decoder/counter circuits. It is very important to minimize noise at this interface. Excessive noise on the encoder input signals may result in loss of counts or extra counts and erroneous closed-loop motion operation. Verify the encoder connections before powering up the system.

Trigger (Position Capture) Inputs

The PCI-7390 offers additional high-performance encoder features. The encoder channels have position capture trigger inputs. These signals are useful for high-speed synchronization of motion with actuators, sensors, and other parts of the complete motion system:

- **Axis <1..4> Trigger Input**—When enabled, an active high-speed position capture input causes instantaneous position capture (<250 ns latency) of the corresponding encoder count value. You can use this high-speed position capture functionality for applications ranging from simple position tagging of sensor data to complex camming systems with advance/retard positioning and registration. An available PCI-7390 position mode is to move an axis relative to a captured position.

Trigger (Position Capture) Input Circuit

The PCI-7390 provides four optically isolated trigger inputs. Figure 4-9 shows a simplified schematic diagram of the circuit used by the trigger inputs. Notice that the trigger inputs are sinking inputs. You can connect the trigger input to a sourcing output device or a TTL driver. The polarity of the trigger input is programmable in software as high level, low level, rising edge, or falling edge. You also can use a trigger input as a latching general-purpose digital input by simply ignoring the captured position.

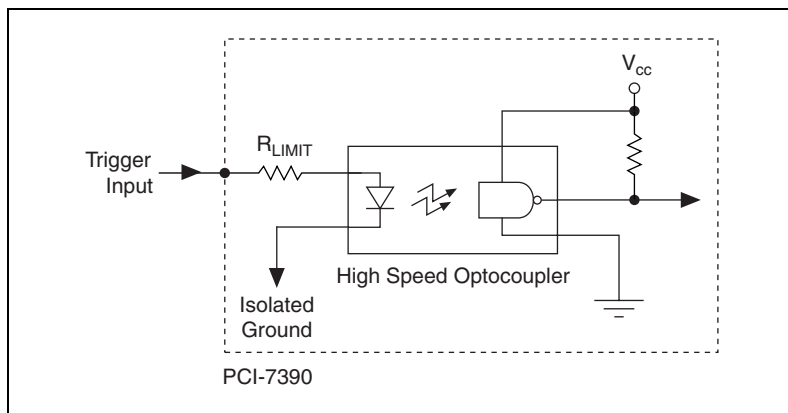


Figure 4-9. Trigger (Position Capture) Input Circuit



Caution Excessive input voltages can cause erroneous operation and/or component failure.

Breakpoint (Position Compare) Outputs

The PCI-7390 offers additional high-performance encoder features. The encoder channels have position compare breakpoint outputs. This signal is useful for high-speed synchronization of motion with actuators, sensors, and other parts of the complete motion system:

- **Axis <1..4> Breakpoint Output**—You can program a breakpoint output to transition when the associated encoder value equals the breakpoint position. You can use a breakpoint output to directly control actuators or as a trigger to synchronize data acquisition or other functions in the motion control system.

You can program breakpoints as either *absolute*, *modulo*, or *relative* position. Breakpoint outputs can be preset to a known state so that the transition when the breakpoint occurs can be low to high, high to low, or toggle.

Breakpoint (Position Compare) Output Circuit

The PCI-7390 provides four optically isolated breakpoint or position compare outputs. Figure 4-10 shows a simplified schematic diagram of the circuit used by the breakpoint outputs. The breakpoint outputs are driven by TTL buffers that feature 24 mA sink and source current capability and built in 20 k Ω pull-up resistors to +5 V.

You can directly set and reset breakpoint outputs to use them as general-purpose digital outputs.

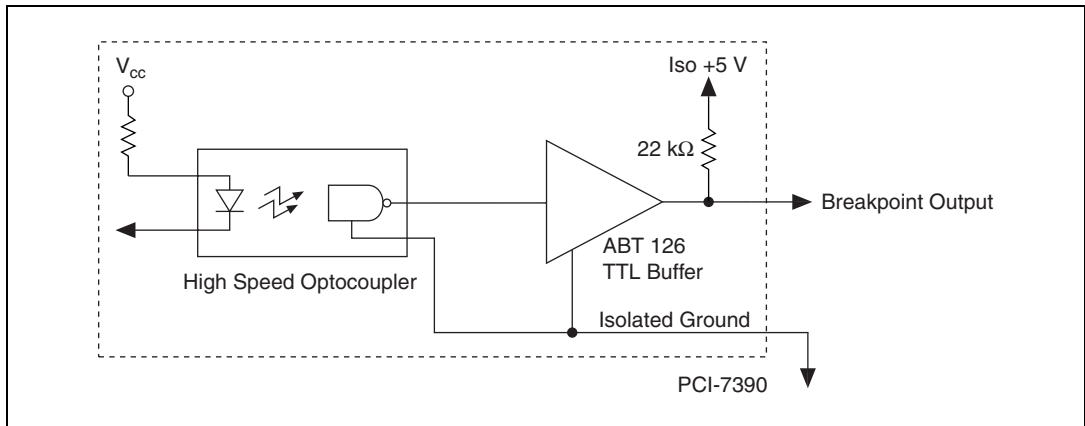


Figure 4-10. Breakpoint (Position Compare) Output Circuit

General-Purpose Inputs

The PCI-7390 provides eight optically isolated sinking or sourcing general-purpose inputs.

- **Axis <1..4> Drive (Servo) Ready**—When enabled in software, the drive ready input can be connected to the drive ready output or servo ready output of the drive. It is a drive status signal indicating that the drive is ready or enabled.
- **Shutdown Input**—When enabled in software, the shutdown input signal can be used to kill all motion by asserting the controller inhibits, stopping any stepper pulse generation, and returning to the default I/O state. The shutdown input is typically connected to an emergency stop switch if it is present in the system.

The input active state of these signals is software programmable for active open or active closed. You can configure any of the eight general-purpose inputs as the shutdown input. The controller must be reset to clear the shutdown state.

Refer to the [Connecting Inputs to the PCI-7390](#) section for detailed information about connecting general-purpose inputs.

General-Purpose Outputs

The PCI-7390 provides eight optically isolated sinking or sourcing general-purpose outputs. Jumpers on the board provide the capability to select between sinking or sourcing per output. Refer to the [Selecting Sinking or Sourcing General-Purpose Outputs](#) section for information about configuring the jumpers.

- **Axis <1..4> Inhibit-Out**—Axis <1..4> General-Purpose Output 1 on each axis is configured by default in software as Axis <1..4> Inhibit-Out. Inhibit output signals can be used to control the enable/inhibit (Servo ON) function of a p-command drive.

When configured, inhibit output signals are activated automatically upon a shutdown (emergency stop) condition, a Kill Motion command, or any motion error that causes a kill motion condition, such as exceeding the following error limit.

- **Axis <1..4> Alarm Clear**—Alarm clear outputs are used to clear the alarm or fault outputs on a p-command drive.

General-Purpose Output Circuit

Figure 4-11 shows the simplified schematic diagram of the general-purpose output circuit. Jumpers on the board provide the ability to choose between a sinking driver or a sourcing driver for each output. The output voltage on the general-purpose outputs depends on the General-Purpose Output Supply input which can range from 5 V to 30 V. The General-Purpose Output Supply is used as the reference voltage for the general purpose outputs. When the a general-purpose output jumper is configured for sourcing the output switches to the voltage supplied on the General-Purpose Output Supply when it is turned on. This supply is used for all eight general-purpose outputs. This supply can be connected to the +24 V IN supply if you are connecting to +24 V devices.



Note You must connect the General-Purpose Output Supply for proper operation of the general-purpose outputs in both sinking and sourcing mode.

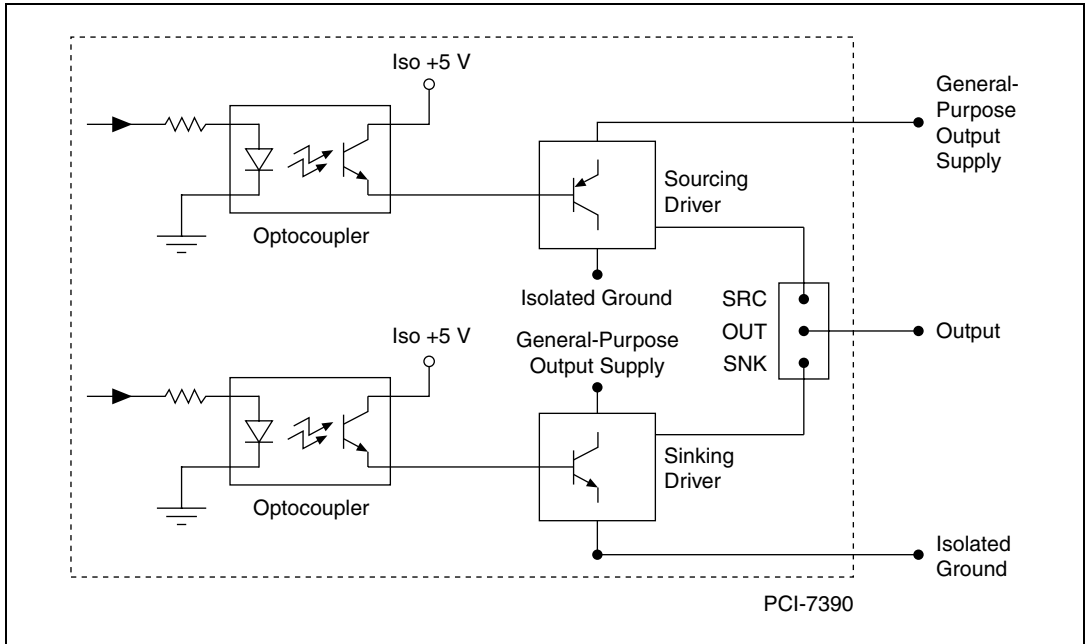


Figure 4-11. General-Purpose Output Circuit

Selecting Sinking or Sourcing General-Purpose Outputs

Use the jumpers on the PCI-7390 to select between sinking and sourcing general-purpose outputs. You can configure each output bit individually. To set the general-purpose output bit as a sourcing output bit, place the jumper across SRC and OUT. To set the output bit as a sinking output bit, place the jumper across OUT and SNK. Refer to Figure 4-12 for the jumper placement. Table 4-3 shows the relationship between the jumper name on the PCI-7390 and the specific output bit you want to configure.

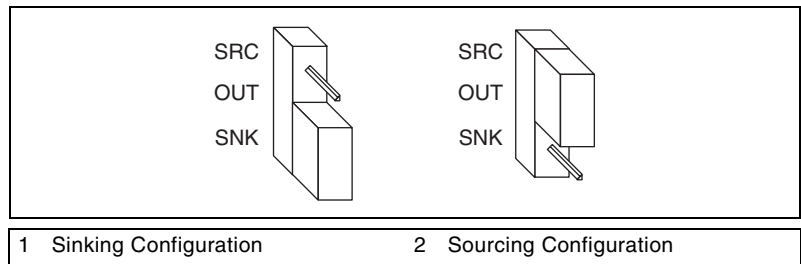


Figure 4-12. General-Purpose Output Jumper Settings

Table 4-3. Jumper Name to General-Purpose Output Bit

Jumper Name	General-Purpose Output Signal
GP1	Axis 1 General-Purpose Output 0
GP2	Axis 2 General-Purpose Output 0
GP3	Axis 3 General-Purpose Output 0
GP4	Axis 4 General-Purpose Output 0
GP5	Axis 1 General-Purpose Output 1
GP6	Axis 2 General-Purpose Output 1
GP7	Axis 3 General-Purpose Output 1
GP8	Axis 4 General-Purpose Output 1

Connecting Inputs to the PCI-7390

Limit, home, inhibit-in (alarm), in-position, and general-purpose inputs are optically isolated sinking or sourcing inputs. Figures 4-13, 4-14, 4-15, and 4-16 show a simplified schematic diagram of the circuit used by these inputs. You can connect these inputs to a current sourcing output device such as a PNP sensor, as shown in Figure 4-13, a sinking output device such as an NPN sensor, as shown in Figure 4-14, a high-side switch, as shown in Figure 4-15, or a low-side switch, as shown in Figure 4-16.

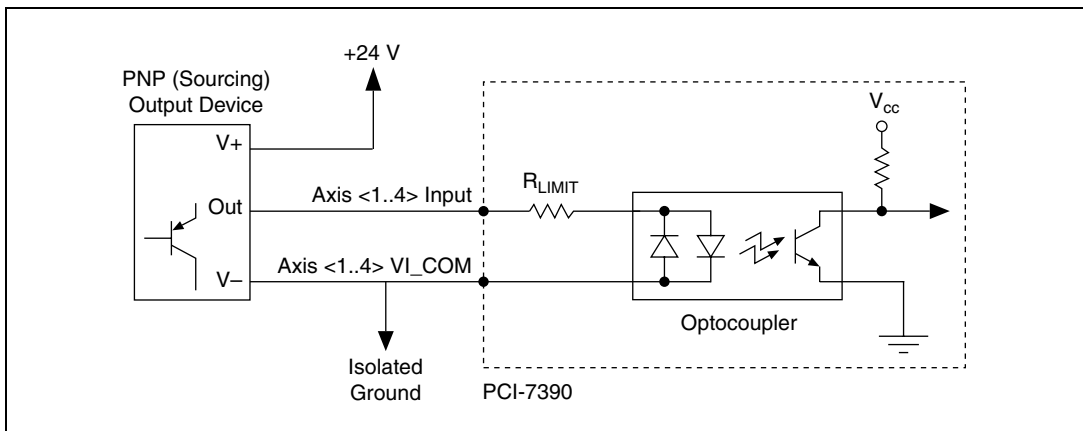


Figure 4-13. Limit, Home, Inhibit-In (Alarm), In-Position, and General-Purpose Input Circuit Connected to a Sourcing Output Device

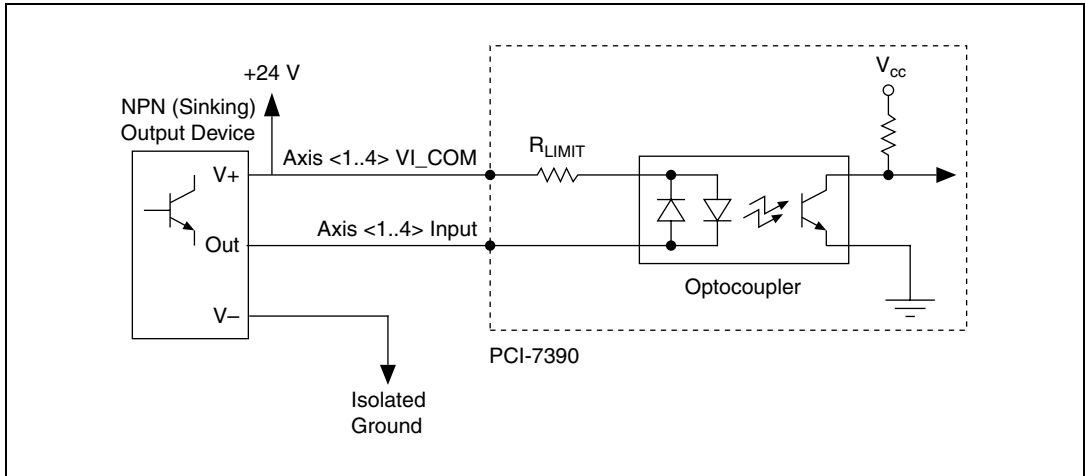


Figure 4-14. Limit, Home, Inhibit-In (Alarm), In-Position, and General-Purpose Input Circuit Connected to a Sinking Output Device

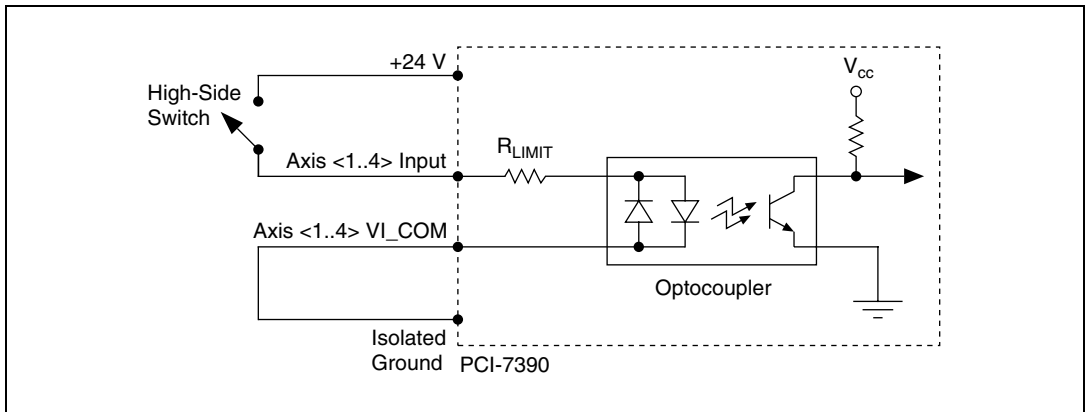


Figure 4-15. Limit, Home, Inhibit-In (Alarm), In-Position, and General-Purpose Input Circuit Connected to a High-Side Switch

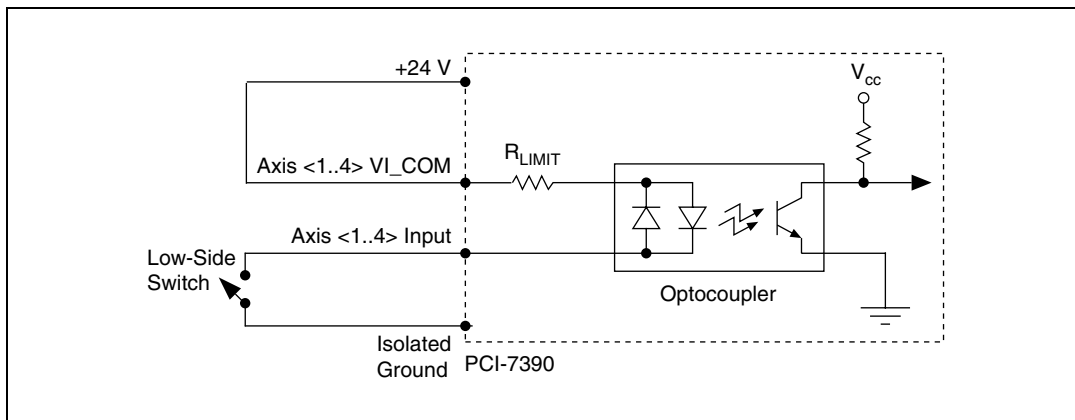


Figure 4-16. Limit, Home, Inhibit-In (Alarm), In-Position, and General-Purpose Input Circuit Connected to a Low-Side Switch



Caution Excessive input voltages can cause erroneous operation and/or component failure. Verify that your input voltage is within the specification range.

The input active state of these signals is software programmable for active open or active closed. Active open refers to a state where the current is not flowing between the input signal and Axis <1..4> VI_COM. Active closed refers to a state where the current is flowing between the input signal and Axis <1..4> VI_COM.

RTSI Connector

The PCI-7390 uses a ribbon cable to connect to other RTSI-capable PCI devices.

RTSI Signal Considerations

The PCI-7390 motion controller allows you to use up to eight RTSI trigger lines as sources for trigger inputs, or as destinations for breakpoint outputs and encoder signals. Breakpoint outputs are output-only signals that generate an active high pulse of 200 ns duration, as shown in Figure 4-17.

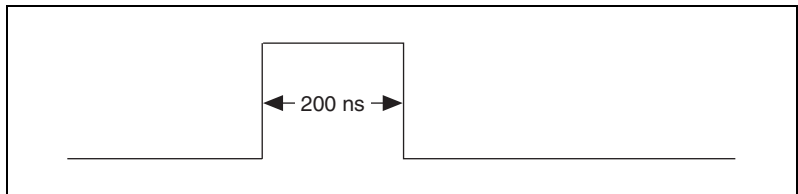


Figure 4-17. Breakpoint across RTSI

Encoder and Index signals are output-only signals across RTSI that are the digitally-filtered versions of the raw signals coming into the controller. If you are using the RTSI bus for motion I/O or generic digital I/O, all signals are passed through unaltered.

Specifications

This appendix lists the hardware and software performance specifications for the NI PCI-7390. All specifications are subject to change without notice. Visit ni.com/manuals for the most current specifications.

Hardware specifications are typical at 25 °C unless otherwise stated.

Stepper Performance

Trajectory update rate range	62.5 to 500 μ s
Maximum update rate	62.5 μ s/axis
4-axis update rate	250 μ s total
Multi-axis synchronization	< 1 update period
Position accuracy	
Open-loop stepper	1 full, half, or microstep
Encoder feedback	± 1 quadrature count
Double-buffered trajectory parameters	
Position range	$\pm 2^{31}$ steps
Maximum relative move size	$\pm 2^{31}$ steps
Velocity range	1 to 4,000,000 steps/s
RPM range	10^{-5} to 10^6 revolutions/minute
Acceleration/deceleration	4,000 to 128,000,000 steps/s ²
RPS/s range	10^{-1} to 10^8 revolutions/s ²
S-curve time range	1 to 32,767 samples
Following error range	1 to 32,767 counts; off (no error checking)
Gear ratio	$\pm 32,767:1$ to $\pm 1:32,767$
Stepper outputs	
Maximum pulse rate	4 MHz (full, half, and microstep)
Minimum pulse width	60 ns at 4 MHz
Step output mode	Step and direction or CW/CCW

Output type	RS-422, line-driver outputs
Voltage range.....	0 to 5 V optically isolated
Output high voltage.....	> 2.4 V at 20 mA
Output low voltage	< 0.4 V at 20 mA
Active state	Programmable, active high or active low
Power-on state	Open/floating

System Reset

Watchdog timer function	Resets board to startup state
Watchdog timeout	63 ms

Motion I/O

Quadrature encoder inputs

Maximum count rate.....	4 MHz quadrature
Minimum pulse width.....	250 ns
Input type.....	Differential (RS-422 compatible)
Voltage range.....	0 to 30 V ¹ , optically isolated
Input on voltage.....	> 3 V at 5 V ¹
Input off voltage	< 1 V at 5 V ¹
Turn-on current.....	14 mA maximum

Forward, reverse, and home inputs

Number of inputs	12 (3 per axis)
Minimum pulse width.....	50 μ s (digital filter disabled)
Input type.....	Sinking or sourcing
Voltage range.....	0 to 30 V, optically isolated
Input on voltage.....	11 to 30 V
Input off voltage	0 to 4 V
Turn-on current	
11 V inputs	4.5 mA maximum
30 V inputs	12.5 mA maximum
Active state	Programmable, active open or active closed

¹ Refer to the [Connections for Input Voltages Higher Than 5 V](#) section of Chapter 4, [Signal Connections](#), for information about connections to higher input voltages.

Inhibit-in (alarm) and in-position inputs

Number of inputs	8 (2 per axis)
Minimum pulse width.....	50 μ s
Input type	Sinking or sourcing
Voltage range	0 to 30 V, optically isolated
Input on voltage	11 to 30 V
Input off voltage	0 to 4 V
Turn-on current	
11 V inputs.....	4.5 mA maximum
30 V inputs.....	12.5 mA maximum
Active state	Programmable, active open or active closed

Trigger (position capture) inputs

Number of inputs	4 (Encoders 1 through 4)
Input type	Sinking
Voltage range	0 to 5 V, optically isolated
Input on voltage	> 3 V
Input off voltage	< 1 V
Turn-on current	14 mA maximum
Active state	Programmable, active high or active low
Minimum pulse width.....	200 ns
Capture latency	< 250 ns
Capture accuracy.....	1 count
Maximum repetitive capture rate....	100 Hz

Breakpoint (position compare) outputs

Number of outputs	4 (encoders 1 through 4)
Output type	TTL
Voltage range.....	0 to 5 V, optically isolated
Output high voltage	> 2.5 V at 16 mA
Output low voltage	< 0.5 V at 10 mA
Active state	Programmable, active high or active low
Pulse width.....	200 ns
Power-on state.....	22 k Ω pullup to isolated +5 V

General-Purpose Digital I/O

Inputs

Number of inputs	8
Minimum pulse width.....	50 μ s
Input type.....	Sinking or sourcing
Voltage range.....	0 to 30 V, optically isolated
Input on voltage.....	11 to 30 V
Input off voltage	0 to 4 V
Turn-on current	
11 V inputs	4.5 mA maximum
30 V inputs	2.5 mA maximum
Active state	Programmable, active open or active closed
Optional functionality.....	Shutdown input, drive (servo) ready input

Outputs

Number of outputs.....	8
Minimum pulse width.....	10 μ s
Output type	Sinking or sourcing (jumper-selectable)
Switching voltage	0 to 30 V maximum ¹
Maximum voltage drop	
Sourcing	2 V at 350 mA
Sinking	1.6 V at 350 mA
Maximum switching current	

Ambient Temperature	Sourcing		Sinking	
	All Outputs (each)	One Output	All Outputs (each)	One Output
Up to 25 °C	75 mA	350 mA	125 mA	475 mA
Up to 55 °C	50 mA	300 mA	100 mA	325 mA

¹ The General-Purpose Output Supply voltage (5 V to 30 V) controls the sourcing output voltage range.

Active state	Programmable, active open or active closed
Power-on state.....	Open
Optional functionality	Inhibit output, alarm clear output

RTSI

Trigger lines	8
---------------------	---

I/O Power Requirements

+24 V input	24 V \pm 10%, 500 mA maximum
General-Purpose Output Supply input	5 to 30 V, 1 A maximum ¹
Isolated +5 V output.....	5 V \pm 5%, 500 mA maximum

Bus Power Requirements

+5 V (\pm 5%)	600 mA maximum
+12 V (\pm 5%)	50 mA maximum

Physical Characteristics

Motion I/O connector.....	100-pin SCSI
Dimensions.....	17.8 \times 9.9 cm (7.03 \times 3.9 in.)
Weight.....	134 g (4.7 oz)

Maximum Working Voltage



Caution These values represent the maximum allowable voltage between any accessible signals on the controller. To determine the acceptable voltage range for a particular signal, please refer to the individual signal specifications.

Channel to earth	30 V
Channel to channel.....	30 V

¹ The General-Purpose Output Supply current depends on the number of general-purpose outputs in use and the total current drawn from all general-purpose outputs.

Environment

The NI PCI-7390 is intended for indoor use only.

Operating temperature0 °C to 55 °C

Storage temperature–20 °C to 70 °C

Relative humidity10% to 90%, noncondensing

Pollution Degree2

Approved at altitudes up to 2,000 m.

Compliance and Certifications

Safety

This product is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1
- CAN/CSA-C22.2 No. 61010-1



Note For UL and other safety certifications, refer to the product label or visit ni.com/certification, search by model number or product line, and click the appropriate link in the Certification column.

Electromagnetic Compatibility

EmissionsEN 55011 Class A at 10 m
FCC Part 15A above 1 GHz

ImmunityEN 61326:1997 + A2:2001,
Table 1

CE, C-Tick, and FCC Part 15 (Class A) Compliant



Note For EMC compliance, operate this device with shielded cabling.

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

Low-Voltage Directive (safety) 73/23/EEC

Electromagnetic Compatibility
Directive (EMC) 89/336/EEC



Note Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, visit ni.com/certification, search by model number or product line, and click the appropriate link in the Certification column.

Motion Connection Accessories

This appendix describes the Motion Connection Accessory (MCA) connectivity blocks for direct connections between the NI PCI-7390 and Mitsubishi, Panasonic, and Yaskawa drives.

Mitsubishi J2S Series Drive Connection Accessory

The NI MCA-7790M accessory (NI part number 779612-01) provides connection between the PCI-7390 and Mitsubishi J2S series drives.

Connecting Mitsubishi Drives to the PCI-7390

To connect a Mitsubishi drive to the PCI-7390, connect two 20-pin cables from the drive to the MCA-7790M, then connect a SCSI 100-pin cable from the MCA-7790M to the PCI-7390. Finally, connect the MCA-7790M to a +24 V power supply using the IGND +24 V two-terminal screw terminal.

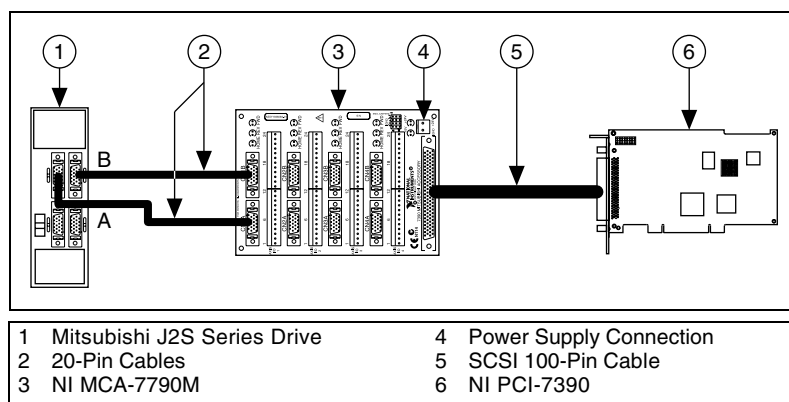


Figure B-1. PCI-7390 Connected to a Mitsubishi J2S Series Drive



Note The Inhibit-Out (Servo ON) input in the drive is sourcing. For compatibility between the drive and the controller, set the general-purpose output jumper on the PCI-7390 for sinking. The MCA-7790M internally connects VI_COM <1..4> to +24 V which configures all PCI-7390 inputs as sourcing.

MCA-7790M LEDs

The MCA-7790M has three LEDs per axis that indicate forward limit, reverse limit, and home status. Two additional LEDs indicate the status of the +24 V input power supply and the +5 V OUT signal from the PCI-7390.

MCA-7790M Axis I/O Signals

Table B-1 shows the signals from the Axis I/O screw terminal on the MCA-7790M to the PCI-7390 and from the drive to the MCA-7790M.

Table B-1. Axis I/O 1 through 4 to PCI-7390 and Mitsubishi J2S Series Drive

Accessory Pin Number	PCI-7390 Signal [†]	Drive Signal
1	Isolated Ground (IGND)	—
2	Isolated Ground	—
3	Isolated +5 V OUT	—
4	+24 V [‡]	—
5	Isolated Ground	—
6	Axis <1..4> General-Purpose Input 0 [‡]	—
7	Axis <1..4> Breakpoint (Position Compare)	—
8	Axis <1..4> Trigger (Position Capture)	—
9	—	EMG (Shutdown/emergency stop) ^{††}
10	Axis <1..4> Home Switch	—
11	Axis <1..4> Reverse Limit Switch	—
12	Axis <1..4> Forward Limit Switch	—
13	Isolated Ground	—
14	—	LG (Control common)
15	Isolated +5 V OUT	—
16	+24 V [‡]	ALM (Trouble)
17	—	RES (Reset)

Table B-1. Axis I/O 1 through 4 to PCI-7390 and Mitsubishi J2S Series Drive (Continued)

Accessory Pin Number	PCI-7390 Signal [†]	Drive Signal
18	—	ZSP (Zero speed)
19	—	PC (Proportion control)
20	—	TLC (Limiting torque)
21	—	TL (Torque limit selection)
22	—	TLA (Analog torque limit)
23	—	VLA (Analog speed limit)
24	—	DO1 (Digital output)

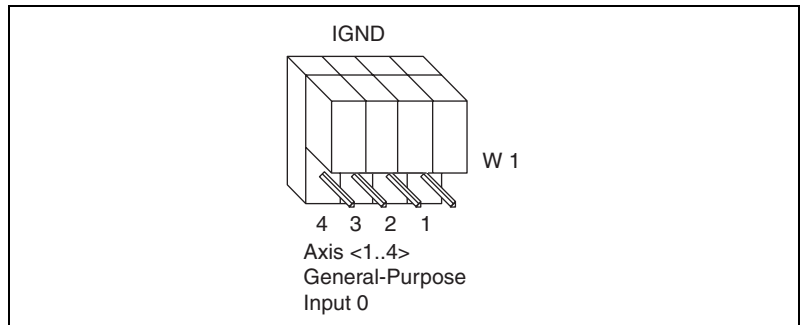
[†] Refer to Figure 4-1, *100-Pin I/O Connector Pin Assignments*, for information about the 100-pin cable pin assignments.

[‡] The +24 V signals are directly connected to the +24 V screw terminal input.

^{††} Jumpers on the MCA-7790M are used to configure the General-Purpose Input 0 and EMG signals on the Axis I/O screw terminal. Refer to the *Configuring the EMG and GPI Signals Using the MCA-7790M* section for configuration information.

Configuring the EMG and GPI Signals Using the MCA-7790M

You can use the EMG jumpers on the MCA-7790M to configure the shutdown (emergency stop) signal on the drive and/or on the PCI-7390 controller. Figure B-2 shows the default EMG jumper configuration on the MCA-7790M.

**Figure B-2.** Default EMG Jumper Settings

Shutdown (Emergency Stop) Signal to Controller Only

By default, the EMG jumpers on the MCA-7790M are placed to connect the EMG input of the drive to isolated ground. In this configuration, the drive is always enabled. The EMG pin on the Axis I/O screw terminal cannot be used in this configuration.

The PCI-7390 Axis <1..4> General-Purpose Input 0 is not connected to the EMG input of the drive. Connect the shutdown (emergency stop) switch or signal to the PCI-7390 Axis <1..4> General-Purpose Input 0 pin on the Axis I/O screw terminal. In software, configure the PCI-7390 Axis <1..4> General-Purpose Input 0 to function as a shutdown (emergency stop) input. In this configuration, the shutdown (emergency stop) signal goes to the controller and stops all axes in the motion control system if the shutdown (emergency stop) signal is active.



Note If you are not connecting an external shutdown (emergency stop) signal to the drive, leave the jumpers in the default configuration. This connects the EMG input of the drive to isolated ground. In this configuration the drive is always enabled.

Combined Shutdown (Emergency Stop) Signal to Controller and Drive

Place the jumper to connect the EMG input of the drive and the PCI-7390 Axis <1..4> General-Purpose Input 0 signal. This jumper setting shorts the EMG pin and General-Purpose Input 0 pin together.



Caution Connect the external shutdown (emergency stop) signal either to the EMG pin or the PCI-7390 Axis <1..4> General-Purpose Input 0 pin, not both pins. Wiring both pins in this configuration could cause permanent damage to your motion system.

You can use the EMG pin or the PCI-7390 Axis <1..4> General-Purpose Input 0 pin on the Axis I/O screw terminal to connect a shutdown (emergency stop) switch or signal to both the drive and the controller. In software, configure the PCI-7390 Axis <1..4> General-Purpose Input 0 to function as a shutdown (emergency stop) input.



Note The drive is enabled (normal operation) when the EMG input is connected to isolated ground.

Shutdown (Emergency Stop) Signal Only to Drive

Remove the jumper. In this configuration the EMG input of the drive is only connected to the EMG pin on the Axis I/O screw terminal. The PCI-7390 Axis <1..4> General-Purpose Input 0 can be used for any general-purpose functionality. The PCI-7390 Axis <1..4> General-Purpose Input 0 signal can be accessed through the Axis I/O screw terminal. Connect the EMG switch or signal to the EMG pin on the Axis I/O screw terminal. In this configuration the shutdown (emergency stop) signal goes only to the drive and stops only the affected axis. The other axes in the motion control system are unaffected.

Separate Shutdown (Emergency Stop) Signals to Controller and Drive

Remove the jumper. In this configuration the EMG input of the drive is only connected to the EMG pin on the Axis I/O screw terminal. Connect separate shutdown (emergency stop) switches or signals to the EMG pin and the PCI-7390 Axis <1..4> General-Purpose Input 0 pin on the Axis I/O screw terminal. In software, configure the PCI-7390 Axis <1..4> General-Purpose Input 0 to function as a shutdown (emergency stop) input. Use the two shutdown (emergency stop) inputs independently as per your requirements. In this configuration, you configure separate shutdown (emergency stop) conditions for the drive and for the controller.

CNA and CNB Cable Pin Assignments

Tables B-2 and B-3 show the pin assignments for the CNA and CNB cables.



Note These tables are provided for reference for custom cable assembly. For custom cables, use the 3M 20-pin MDR connector part number 10120-6000EC and 3M MDR backshell part number 10320-3210-000.

Table B-2. CN1A through CN4A Pin Assignments

Accessory Signal	CNA Pin Number	Drive Signal
Line Ground	1	LG (Control common)
Axis <1..4> Dir (CCW)+	2	NP (Forward rotation pulse train)
Axis <1..4> Step (CW)+	3	PP (Reverse rotation pulse train)
NC (No connection)	4	P15R (15 VDC power supply)
Axis <1..4> Index (Encoder Phase Z)+	5	LZ (Encoder index phase)
Axis <1..4> Encoder Phase A+	6	LA (Encoder A phase)
Axis <1..4> Encoder Phase B+	7	LB (Encoder B phase)
Axis <1..4> General Purpose Output 0	8	CR (Clear)
+24 V	9	COM (power supply input signal)
Isolated Ground	10	SG (Digital I/F common)
NC	11	OPC (Open collector power input)
Axis <1..4> Dir (CCW) –	12	NG (Forward rotation pulse train)
Axis <1..4> Step (CW)–	13	PG (Reverse rotation pulse train)
NC	14	OP (Encoder Z phase pulse (open collector))
Axis <1..4> Index (Encoder Phase Z)–	15	LZR (Encoder index phase)
Axis <1..4> Encoder Phase A–	16	LAR (Encoder A phase)
Axis <1..4> Encoder Phase B–	17	LBR (Encoder B phase)
Axis <1..4> In-Position	18	INP (In-position)
Axis <1..4> General Purpose Input 1	19	RD (Ready)
Isolated Ground	20	SG (Digital I/F common)

Table B-3. CN1B through CN4B Pin Assignments

Accessory Signal	CNB Pin Number	Drive Signal
Line Ground	1	LG (Control common)
VLA	2	VC/VLA (Analog speed limit)
NC	3	VDD (I/F internal power supply)
DO1	4	DO1 (Digital output)
Axis <1..4> Inhibit-Out/General Purpose Output 1	5	SON (Servo On)
TLC	6	TLC (Torque limit control)
NC	7	LOP/SP2 (Control change/Speed selection 2)
PC	8	PC/ST1/RS2 (Proportion control)
TL	9	TL/ST2/RS1 (Torque limit selection)
Isolated Ground	10	SG (Digital I/F common)
NC	11	P15R (15 VDC power supply)
TLA	12	TLA/TC (Analog torque limit)
+24 V	13	COM (Digital I/F power supply input)
RES	14	RES (Reset)
EMG [†]	15	EMG (Emergency stop)
Isolated Ground	16	LSP (Forward rotation stroke end)
Isolated Ground	17	LSN (Reverse rotation stroke end)
Axis <1..4> Inhibit-In (Alarm)	18	ALM (Alarm)
ZSP	19	ZSP (Zero speed)
Isolated Ground	20	SG (Digital I/F common)
† This signal must be grounded for the drive to function correctly.		

Panasonic Minas A Series Drive Connection Accessory

The NI MCA-7790P accessory (NI part number 779613-01) provides connection between the PCI-7390 and Panasonic MINAS A series drives.

Connecting Panasonic Drives to the PCI-7390

To connect a Panasonic drive to the PCI-7390, connect a 50-pin cable from the drive to the MCA-7790P, then connect a SCSI 100-pin cable from the MCA-7790P to the PCI-7390. Finally, connect the MCA-7790P to a +24 V power supply using the IGND +24 V two-terminal screw terminal.



Note The Inhibit-Out (Servo ON) input in the drive is sourcing. For compatibility between the drive and the controller, set the general-purpose output jumper on the PCI-7390 for sinking. The MCA-7790P internally connects VI_COM <1..4> to +24 V which configures all PCI-7390 inputs as sourcing.

MCA-7790P LEDs

The MCA-7790P has three LEDs per axis that indicate forward limit, reverse limit, and home status. Two additional LEDs indicate the status of the +24 V input power supply and the +5 V OUT signal from the PCI-7390.

MCA-7790P Axis I/O Signals

Table B-4 shows the signals from the Axis I/O screw terminal on the MCA-7790P to the PCI-7390 and from the drive to the MCA-7790P.

Table B-4. Axis I/O 1 through 4 to PCI-7390 and Panasonic MINAS A Series Drive

Accessory Pin Number	PCI-7390 Signal [†]	Drive Signal
1	Axis <1..4> Breakpoint (Position Compare)	—
2	Axis <1..4> Trigger (Position Capture)	—
3	Isolated +5V OUT	—
4	Isolated Ground (IGND)	—
5	+24 V [‡]	—
6	Isolated Ground	—

Table B-4. Axis I/O 1 through 4 to PCI-7390 and Panasonic MINAS A Series Drive (Continued)

Accessory Pin Number	PCI-7390 Signal [†]	Drive Signal
7	Axis <1..4> General-Purpose Input 0	—
8	Axis <1..4> Home Switch	—
9	Axis <1..4> Reverse Limit Switch	—
10	Axis <1..4> Forward Limit Switch	—
11	Axis <1..4> General-Purpose Output 0	—
12	—	CL (Position error counter clear)
13	+24 V [‡]	—
14	Isolated Ground	—
15	—	BRK-OFF- (Mechanical break release)
16	—	BRK-OFF+ (Mechanical break release)
17	Isolated Ground	—
18	—	DIV (Command pulse scalar switch)
19	—	SP (Velocity monitor output)
20	—	IM (Torque monitor output)
21	—	TLC (Torque in-limit)
22	—	C-MODE (Control mode switching)
23	—	GAIN (Gain switching)
24	—	ZEROSPD (Speed zero clamp)
25	+24 V [‡]	—
26	—	INH (Pulse inhibit)
27	Isolated Ground	—
28	—	CWTL (CW torque limit)
29	—	CCWTL/TRQR (CCW torque limit)
30	—	SPR/TRQR (Velocity (torque) command)

Table B-4. Axis I/O 1 through 4 to PCI-7390 and Panasonic MINAS A Series Drive (Continued)

Accessory Pin Number	PCI-7390 Signal [†]	Drive Signal
31	—	ZSP (Zero speed detection)
32	—	A-CLR (Alarm clear)

[†] Refer to Figure 4-1, *100-Pin I/O Connector Pin Assignments*, for information about the 100-pin cable pin assignments.

[‡] The +24 V signals are directly connected to the +24 V screw terminal input.

CN I/F Cable Pin Assignments

Table B-5 shows the pin assignments for the CN I/F cable.



Note This table is provided for reference for custom cable assembly. For custom cables, use the 3M 50-pin MDR connector part number 10150-6000EC and 3M backshell part number 10350-3210-000.

Table B-5. CN I/F Cable Pin Assignments

Accessory Signal	Pin Number	Drive Signal
NC (No connection)	1	NC
NC	2	NC
Axis <1..4> Step (CW)+	3	PULS1 (Command pulse)
Axis <1..4> Step (CW)-	4	PULS2 (Command pulse)
Axis <1..4> Dir (CCW)+	5	SIGN1 (Command sign)
Axis <1..4> Dir (CCW)-	6	SIGN2 (Command sign)
+24 V	7	COM+ (Control signal power (+))
Isolated Ground	8	CWL (CW overtravel limit)
Isolated Ground	9	CCWL (CCW overtravel limit)
BRK_OFF-	10	BRK-OFF- (Mechanical brake release)
BRK_OFF+	11	BRK-OFF+ (Mechanical brake release)
ZSP	12	ZSP (Zero speed detection)
Isolated Ground	13	GND (Signal ground)

Table B-5. CN I/F Cable Pin Assignments (Continued)

Accessory Signal	Pin Number	Drive Signal
SPR_TRQR	14	SPR/TRQR (Velocity (torque) command)
Isolated Ground	15	GND (Signal ground)
CCWTL_TRQR	16	CCWTL/TRQR (CCW torque limit)
Isolated Ground	17	GND (Signal ground)
CWTL	18	CWTL (CW torque limit)
NC	19	CZ (open-collector Z-phase output)
NC	20	NC
Axis <1..4> Encoder Phase A+	21	OA+ (A-phase output)
Axis <1..4> Encoder Phase A-	22	OA- (A-phase output)
Axis <1..4> Index (Encoder Phase Z)+	23	OZ+ (Z-phase output)
Axis <1..4> Index (Encoder Phase Z) -	24	OZ- (Z-phase output)
Isolated Ground	25	GND (Signal ground)
ZEROSPD	26	ZEROSPD (Speed zero clamp)
GAIN	27	GAIN (Gain switching)
DIV	28	DIV (Command pulse scalar switch)
Axis <1..4> Inhibit-Out/ General-Purpose Output 1	29	SRV-ON (Servo-ON)
CL	30	CL (Counter clear)
A_CLR	31	A-CLR (Alarm clear)
C_MODE	32	C-MODE (Control mode switching)
INH	33	INH (Command pulse input inhibit)
Isolated Ground	34	S-RDY- (Servo-ready)
Axis <1..4> General-Purpose Input 1	35	S-RDY+ (Servo-ready)
Isolated Ground	36	ALM- (Servo alarm)
Axis <1..4> Inhibit-In (Alarm)	37	ALM+ (Servo alarm)

Table B-5. CN I/F Cable Pin Assignments (Continued)

Accessory Signal	Pin Number	Drive Signal
Isolated Ground	38	COIN- (In-position)
Axis <1..4> In-Position	39	COIN+ (In-position)
TLC	40	TLC (Torque in-limit)
Isolated Ground	41	COM- (Control signal power (-))
IM	42	IM (Torque monitor output)
SP	43	SPM (Velocity monitor output)
NC	44	BATT+ (Battery+)
NC	45	BATT- (Battery-)
NC	46	NC
NC	47	NC
Axis <1..4> Encoder Phase B+	48	OB+ (B-phase output)
Axis <1..4> Encoder Phase B-	49	OB- (B-phase output)
Isolated Ground	50	FG (Frame ground)

Yaskawa Sigma II Series Drive Connection Accessory

The NI MCA-7790Y accessory (NI part number 779611-01) provides connection between the PCI-7390 and Yaskawa Sigma II series drives.

Connecting Yaskawa Drives to the PCI-7390

To connect a Yaskawa drive to the PCI-7390, connect a 50-pin cable from the drive to the MCA-7790Y, then connect a SCSI 100-pin cable from the MCA-7790Y to the PCI-7390. Finally, connect the MCA-7790Y to a +24 V power supply using the IGND +24 V two-terminal screw terminal.



Note The Inhibit-Out (Servo ON) input in the drive is sourcing. For compatibility between the drive and the controller, set the general-purpose output jumper on the PCI-7390 for sinking. The MCA-7790Y internally connects VL_COM <1..4> to +24 V which configures all PCI-7390 inputs as sourcing.

MCA-7790Y LEDs

The MCA-7790Y has three LEDs per axis that indicate forward limit, reverse limit, and home status. Two additional LEDs indicate the status of the +24 V input power supply and the +5 V OUT signal from the PCI-7390.

MCA-7790Y Axis I/O Signals

Table B-6 shows the signals from the Axis I/O screw terminal on the MCA-7790Y to the PCI-7390 and from the drive to the MCA-7790Y.

Table B-6. Axis I/O 1 through 4 to PCI-7390 and Yaskawa Sigma II Series Drive

Accessory Pin Number	PCI-7390 Signal†	Drive Signal
1	Axis <1..4> Breakpoint (Position Compare)	—
2	Axis <1..4> Trigger (Position Capture)	—
3	Isolated +5 V OUT	—
4	Isolated Ground (IGND)	—
5	+24 V‡	—
6	Isolated Ground	—

Table B-6. Axis I/O 1 through 4 to PCI-7390 and Yaskawa Sigma II Series Drive (Continued)

Accessory Pin Number	PCI-7390 Signal [†]	Drive Signal
7	Axis <1..4> General-Purpose Input 0	—
8	Axis <1..4> Home Switch	—
9	Axis <1..4> Reverse Limit Switch	—
10	Axis <1..4> Forward Limit Switch	—
11	Axis <1..4> General-Purpose Output 0	—
12	—	CLR (Clear input)
13	+24 V [‡]	—
14	Isolated Ground	—
15	—	P-CON (P operation input)
16	—	T-REF (Torque reference input)
17	—	V-REF (Reference speed input)
18	—	SEN (SEN signal input)
19	—	/TGON (TGON signal output)
20	—	/TGON+ (TGON signal output)
21	+24 V [‡]	—
22	Isolated Ground	—
23	—	/N-CL (Reverse current limit ON input)
24	—	/P-CL (Forward current limit ON input)
25	—	/ALM-RST (Alarm reset input)
26	—	AL03 (Open-collector output)
27	—	AL02 (Alarm code output)
28	—	AL01 (Alarm code output)

Table B-6. Axis I/O 1 through 4 to PCI-7390 and Yaskawa Sigma II Series Drive (Continued)

Accessory Pin Number	PCI-7390 Signal [†]	Drive Signal
29	—	/PSO (S-phase signal output)
30	—	PSO (S-phase signal output)

[†] Refer to Figure 4-1, *100-Pin I/O Connector Pin Assignments*, for information about the 100-pin cable pin assignments.

[‡] The +24 V signals are directly connected to the +24 V screw terminal input.

CN1 Cable Pin Assignments

Table B-7 shows the pin assignments for the CN1 cable.



Note This table is provided for reference for custom cable assembly. For custom cables, use the 3M 50-pin MDR connector part number 10150-6000EC and 3M backshell part number 10350-3210-000.

Table B-7. CN1 Cable Pin Assignments

Accessory Signal	Pin Number	Drive Signal
Isolated Ground	1	SG (Signal ground)
Isolated Ground	2	SG (Signal ground)
NC (No connection)	3	PL1 (Open-collector reference power supply)
SEN	4	SEN (SEN signal input)
V_REF	5	V-REF (Reference speed input)
Isolated Ground	6	SG (Signal ground)
Axis <1..4> Step (CW)+	7	PULS (Reference pulse input)
Axis <1..4> Step (CW)-	8	/PULS (Reference pulse input)
T_REF	9	T-REF (Torque reference input)
Isolated Ground	10	SG (Signal ground)
Axis <1..4> Dir (CCW)+	11	SIGN (Reference sign input)
Axis <1..4> Dir (CCW)-	12	/SIGN (Reference sign input)

Table B-7. CN1 Cable Pin Assignments (Continued)

Accessory Signal	Pin Number	Drive Signal
NC	13	PL2 (Open-collector reference for power supply)
CLR	14	/CLR (Clear input)
PL3 [†]	15	CLR (Clear input)
NC	16	NC
NC	17	NC
PL3 [†]	18	PL3 (Open-collector reference for power supply)
Axis <1..4> Index (Encoder Phase Z)+	19	PCO (PG divided output C-phase)
Axis <1..4> Index (Encoder Phase Z)-	20	/PCO (PG divided output C-phase)
NC	21	BAT (+) (Battery (+))
NC	22	BAT (-) (Battery (-))
NC	23	NC
NC	24	NC
Axis <1..4> In-Position	25	/V-CMP+ (/COIN+) (Speed coincidence detection output)
Isolated Ground	26	/V-CMP- (/COIN-) (Speed coincidence detection output)
TGON+	27	/TGON+ (TGON signal output)
TGON-	28	TGON (TGON signal output)
Axis <1..4> General-Purpose Input 1	29	/S-RDY+ (Servo ready output)
Isolated Ground	30	/S-RDY (Servo ready output)
Axis <1..4> Inhibit-In (Alarm)	31	ALM+ (Servo alarm output)
Isolated Ground	32	ALM (Servo alarm output)
Axis <1..4> Encoder Phase A+	33	PAO (PG divided output A-phase)

Table B-7. CN1 Cable Pin Assignments (Continued)

Accessory Signal	Pin Number	Drive Signal
Axis <1..4> Encoder Phase A–	34	/PAO (PG divided output A-phase)
Axis <1..4> Encoder Phase B+	35	PBO (PG divided output B-phase)
Axis <1..4> Encoder Phase B–	36	/PBO (PG divided output B-phase)
AL01	37	AL01 (Alarm code output)
AL02	38	AL02 (Alarm code output)
AL03	39	AL03 (Open-collector output)
Axis <1..4> Inhibit-Out/ General-Purpose Output 1	40	/S-ON (Servo ON input)
P_CON	41	P-CON (P operation input)
Isolated Ground	42	P-OT (Forward overtravel input)
Isolated Ground	43	N-OT (Reverse overtravel input)
ALM_RS	44	/ALM-RST (Alarm reset input)
P_CL	45	/P-CL (Forward current limit ON input)
N_CL	46	/N-CL (Reverse current limit ON input)
+24 V	47	+24 V-IN (External input power supply)
PSO+	48	PSO (S-phase signal output)
PSO–	49	/PSO (S-phase signal output)
NC	50	NC
† Pins 15 and 18 are connected together on the accessory but are not available on the Axis I/O screw terminal.		



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Glossary

Symbol	Prefix	Value
μ	micro	10^{-6}
m	milli	10^{-3}
M	mega	10^6

Numbers/Symbols

/	per
%	percent
\pm	plus or minus
+5 V	+5 VDC source signal

A

A	Amperes
absolute mode	Treat the target position loaded as position relative to zero (0) while making a move.
absolute position	Position relative to zero.
active closed	A signal is active when current is flowing through the optocoupled input.
active high	A signal is active when its value goes high (1).
active low	A signal is active when its value goes low (0).
active open	A signal is active when current is not flowing through the optocoupled input.
address	Character code that identifies a specific location (or series of locations) in memory or on a host PC bus system.

amplifier The drive that delivers power to operate the motor in response to low level control signals. In general, the amplifier is designed to operate with a particular motor type—you cannot use a stepper drive to operate a DC brush motor, for instance.

API application programming interface

axis Unit that controls a motor or any similar motion or control device.

B

b bit—one binary digit, either 0 or 1.

base address Memory address that serves as the starting address for programmable or I/O bus registers. All other addresses are located by adding to the base address.

binary A number system with a base of 2.

buffer Temporary storage for acquired or generated data (software).

bus The group of conductors that interconnect individual circuitry in a computer. Typically, a bus is the expansion vehicle to which I/O or other devices are connected.

byte Eight related bits of data, an eight-bit binary number. Also used to denote the amount of memory required to store one byte of data.

C

CCW counter-clockwise—implies direction of motor rotation.

closed-loop A motion system that uses a feedback device to provide position and velocity data for status reporting and accurately controlling position and velocity.

common Reference signal for digital I/O.

crosstalk An unwanted signal on one channel due to an input on a different channel.

CSR communications status register

CW clockwise—implies direction of motor rotation.

D

dedicated	Assigned to a particular function.
DGND	digital ground signal
DLL	dynamically-linked library—provides the API for the motion control boards.
drivers	Software that communicates commands to control a specific motion control board.
DSP	digital signal processor

E

encoder	Device that translates mechanical motion into electrical signals; used for monitoring position or velocity in a closed-loop system.
encoder resolution	The number of encoder lines between consecutive encoder indexes (marker or Z-bit). If the encoder does not have an index output the encoder resolution can be referred to as lines per revolution.

F

f	farad
FIFO	first-in, first-out
filtering	A type of signal conditioning that filters unwanted signals from the signal being measured.
flash ROM	A type of electrically reprogrammable read-only memory.
following error trip point	The difference between the instantaneous commanded trajectory position and the feedback position. If the following error increases beyond the maximum allowable value entered—referred to as the following error trip point—the motor trips on following error and is killed, preventing the axis from running away.
FPGA	field programmable gate array

freewheel The condition of a motor when power is de-energized and the motor shaft is free to turn with only frictional forces to impede it.

full-step Full-step mode of a stepper motor—for a two phase motor this is done by energizing both windings or phases simultaneously.

G

Gnd ground

GND ground

H

half-step Mode of a stepper motor—for a two phase motor this is done by alternately energizing two windings and then only one. In half step mode, alternate steps are strong and weak but there is significant improvement in low-speed smoothness over the full-step mode.

hex hexadecimal

home switch (input) A physical position determined by the mechanical system or designer as the reference location for system initialization. Frequently, the home position also is regarded as the zero position in an absolute position frame of reference.

host computer Computer into which the motion control board is plugged.

I

I/O input/output—the transfer of data to and from a computer system involving communications channels, operator interface devices, and/or motion control interfaces.

ID identification

IGND isolated ground

index Marker between consecutive encoder revolutions.

inverting	The polarity of a switch (limit switch, home switch, and so on) in <i>active</i> state. If these switches are active low they are said to have inverting polarity. <i>See also</i> active low .
IRQ	interrupt request
K	
k	kilo—the standard metric prefix for 1,000, or 10^3 , used with units of measure such as volts, hertz, and meters.
K	kilo—the prefix for 1,024, or 2^{10} , used with byte (B) in quantifying data or computer memory.
L	
LIFO	last-in, first-out
limit switch/ end-of-travel position (input)	Sensors that alert the control electronics that physical end of travel is being approached and that the motion should stop.
M	
m	meters
MCS	move complete status
microstep	The proportional control of energy in the coils of a stepper motor that allow the motor to move to or stop at locations other than the fixed magnetic/mechanical pole positions determined by the motor specifications. This capability facilitates the subdivision of full mechanical steps on a stepper motor into finer microstep locations that greatly smooth motor running operation and increase the resolution or number of discrete positions that a stepper motor can attain in each revolution.
modulo position	Treat the position as within the range of total quadrature counts per revolution for an axis.

N

NC	not connected
noise	An undesirable electrical signal. Noise comes from external sources such as the AC power line, motors, generators, transformers, fluorescent lights, soldering irons, CRT displays, computers, electrical storms, welders, radio transmitters, and internal sources such as semiconductors, resistors, and capacitors. Noise corrupts signals you are trying to send or receive.
non-inverting	The polarity of a switch (limit switch, home switch, etc.) in <i>active</i> state. If these switches are active high, they are said to have non-inverting polarity. <i>See also</i> active high .
NPN sensor	A sensor type with a sinking only output stage.

O

open-loop	Refers to a motion control system where no external sensors (feedback devices) are used to provide position or velocity correction signals.
-----------	---

P

PCI	peripheral component interconnect—a high-performance expansion bus architecture originally developed by Intel to replace ISA and EISA. It is achieving widespread acceptance as a standard for PCs and workstations; it offers a theoretical maximum transfer rate of 132 MB/s.
PNP sensor	A sensor type with a sourcing only output stage.
port	(1) A communications connection on a computer or a remote controller. (2) A digital port, consisting of eight lines of digital input and/or output.
position breakpoint	Position breakpoint for an encoder can be set in absolute or relative quadrature counts. When the encoder reaches a position breakpoint, the associated breakpoint output immediately transitions.

power cycling	Turning the host computer off and then back on, which causes a reset of the motion control board.
PWM	pulse width modulation—a method of controlling the average current in a motor phase winding by varying the on-time (duty cycle) of transistor switches.

Q

quadrature counts	The encoder line resolution times four.
-------------------	---

R

RAM	random-access memory
relative breakpoint	Sets the position breakpoint for an encoder in relative quadrature counts.
relative position	Destination or target position for motion specified with respect to the current location regardless of its value.
relative position mode	Treat the target position loaded as position relative to current position while making a move.
ribbon cable	A flat cable in which the conductors are side by side.
ROM	read-only memory—non-volatile memory used for storing code, programs, and data.
RPM	revolutions per minute—units for velocity.
RPSPS or RPS/S	revolutions per second squared—units for acceleration and deceleration.
RTR	ready to receive
RTSI	real-time system integration bus—the National Instruments timing bus that connects devices directly, by means of connectors on top of the devices, for precise synchronization of functions.

S

s	seconds
sinking device	An output device that provides a current path to ground. Also referred to as a low-side switch.
sourcing device	An output device that provides a current supply to power. Also referred to as a high-side switch.
stepper	Specifies an axis that controls a stepper motor.

T

toggle	Changing state from high to low, back to high, and so on.
torque	Force tending to produce rotation.
trapezoidal profile	A typical motion trajectory, where a motor accelerates up to the programmed velocity using the programmed acceleration, traverses at the programmed velocity, then decelerates at the programmed acceleration to the target position
trigger	Any event that causes or starts some form of data capture.
TTL	transistor-transistor logic

V

V	volts
V_{CC}	Positive voltage supply.
velocity mode	Move the axis continuously at the specified velocity.

W

watchdog	A timer task that shuts down (resets) the motion control controller if any serious error occurs.
word	The standard number of bits that a processor or memory manipulates at one time, typically 8-, 16-, or 32-bit.

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