ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

Expert team | Trust guarantee | 100% satisfaction

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Find the *National Instruments NI 9512* at our website: ***Click HERE***

Motion Control

NI 951x User Manual

December 2013
372153E-01

NATIONAL INSTRUMENTS

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Worldwide Technical Support and Product Information

ni.com

Worldwide Offices

Visit ni.com/niglobal to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

National Instruments Corporate Headquarters

11500 North Mopac Expressway Austin, Texas 78759-3504 USA Tel: 512 683 0100

For further support information, refer to the *Technical Support and Professional Services* appendix. To comment on National Instruments documentation, refer to the National Instruments Web site at ni.com/info and enter the Info Code feedback.

© 2009–2013 National Instruments. All rights reserved.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Legal Information

Warranty

NI devices are warranted against defects in materials and workmanship for a period of one year from the invoice date, as evidenced by receipts or other documentation. National Instruments will, at its option, repair or replace equipment that proves to be defective during the warranty period. This warranty includes parts and labor.

The media on which you receive National Instruments software are warranted not to fail to execute programming instructions, due to defects in materials and workmanship, for a period of 90 days from the invoice date, as evidenced by receipts or other documentation. National Instruments will, at its option, repair or replace software media that do not execute programming instructions if National Instruments receives notice of such defects during the warranty period. National Instruments does not warrant that the operation of the software shall be uninterrupted or error free.

A Return Material Authorization (RMA) number must be obtained from the factory and clearly marked on the outside of the package before any equipment will be accepted for warranty work. National Instruments will pay the shipping costs of returning to the owner parts which are covered by warranty.

National Instruments believes that the information in this document is accurate. The document has been carefully reviewed for technical accuracy. In the event that technical or typographical errors exist, National Instruments reserves the right to make changes to subsequent editions of this document without prior notice to holders of this edition. The reader should consult National Instruments if errors are suspected. In no event shall National Instruments be liable for any damages arising out of or related to this document or the information contained in it.

EXCEPT AS SPECIFIED HEREIN, NATIONAL INSTRUMENTS MAKES NO WARRANTIES, EXPRESS OR IMPLIED, AND SPECIFICALLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. CUSTOMER'S RIGHT TO RECOVER DAMAGES CAUSED BY FAULT OR NEGLIGENCE ON THE PART OF NATIONAL INSTRUMENTS SHALL BE LIMITED TO THE AMOUNT THERETOFORE PAID BY THE CUSTOMER. NATIONAL INSTRUMENTS WILL NOT BE LIABLE FOR DAMAGES RESULTING FROM LOSS OF DATA, PROFITS, USE OF PRODUCTS, OR INCIDENTAL OR CONSEQUENTIAL DAMAGES, EVEN IF ADVISED OF THE POSSIBILITY THEREOF. This limitation of the liability of National Instruments will apply regardless of the form of action, whether in contract or tort, including negligence. Any action against National Instruments must be brought within one year after the cause of action accrues. National Instruments shall not be liable for any delay in performance due to causes beyond its reasonable control. The warranty provided herein does not cover damages, defects, malfunctions, or service failures caused by owner's failure to follow the National Instruments installation, operation, or maintenance instructions; owner's modification of the product; owner's abuse, misuse, or negligent acts; and power failure or surges, fire, flood, accident, actions of third parties, or other events outside reasonable control.

Copyright

Under the copyright laws, this publication may not be reproduced or transmitted in any form, electronic or mechanical, including photocopying, recording, storing in an information retrieval system, or translating, in whole or in part, without the prior written consent of National Instruments Corporation.

National Instruments respects the intellectual property of others, and we ask our users to do the same. NI software is protected by copyright and other intellectual property laws. Where NI software may be used to reproduce software or other materials belonging to others, you may use NI software only to reproduce materials that you may reproduce in accordance with the terms of any applicable license or other legal restriction.

End-User License Agreements and Third-Party Legal Notices

You can find end-user license agreements (EULAs) and third-party legal notices in the following locations:

- Notices are located in the `<National Instruments>\_Legal Information` and `<National Instruments>` directories.
- EULAs are located in the `<National Instruments>\Shared\MDF\Legal\license` directory.
- Review `<National Instruments>\_Legal Information.txt` for more information on including legal information in installers built with NI products.

Trademarks

Refer to the *NI Trademarks and Logo Guidelines* at `ni.com/trademarks` for more information on National Instruments trademarks.

ARM, Keil, and µVision are trademarks or registered of ARM Ltd or its subsidiaries.

LEGO, the LEGO logo, WEDO, and MINDSTORMS are trademarks of the LEGO Group. ©2013 The LEGO Group.

TETRIX by Pitsco is a trademark of Pitsco, Inc.©2013

FIELDBUS FOUNDATION™ and FOUNDATION™ are trademarks of the Fieldbus Foundation.

EtherCAT® is a registered trademark of and licensed by Beckhoff Automation GmbH.

CANopen® is a registered Community Trademark of CAN in Automation e.V.

DeviceNet™ and EtherNet/IP™ are trademarks of ODVA.

Go!, SensorDAQ, and Vernier are registered trademarks of Vernier Software & Technology. Vernier Software & Technology and `vernier.com` are trademarks or trade dress.

Xilinx is the registered trademark of Xilinx, Inc.

Taptite and Trilobular are registered trademarks of Research Engineering & Manufacturing Inc.

FireWire® is the registered trademark of Apple Inc.

Linux® is the registered trademark of Linus Torvalds in the U.S. and other countries.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Handle Graphics®, MATLAB®, Real-Time Workshop®, Simulink®, Stateflow®, and xPC TargetBox® are registered trademarks, and TargetBox™ and Target Language Compiler™ are trademarks of The MathWorks, Inc.

Tektronix®, Tek, and Tektronix, Enabling Technology are registered trademarks of Tektronix, Inc.

The Bluetooth® word mark is a registered trademark owned by the Bluetooth SIG, Inc.

The ExpressCard™ word mark and logos are owned by PCMCIA and any use of such marks by National Instruments is under license.

The mark LabWindows is used under a license from Microsoft Corporation. Windows is a registered trademark of Microsoft Corporation in the United States and other countries.

Other product and company names mentioned herein are trademarks or trade names of their respective companies.

Members of the National Instruments Alliance Partner Program are business entities independent from National Instruments and have no agency, partnership, or joint-venture relationship with National Instruments.

Patents

For patents covering National Instruments products/technology, refer to the appropriate location: **Help»Patents** in your software, the `patents.txt` file on your media, or the *National Instruments Patent Notice* at `ni.com/patents`.

Export Compliance Information

Refer to the *Export Compliance Information* at `ni.com/legal/export-compliance` for the National Instruments global trade compliance policy and how to obtain relevant HTS codes, ECCNs, and other import/export data.

WARNING REGARDING USE OF NATIONAL INSTRUMENTS PRODUCTS

(1) NATIONAL INSTRUMENTS PRODUCTS ARE NOT DESIGNED WITH COMPONENTS AND TESTING FOR A LEVEL OF RELIABILITY SUITABLE FOR USE IN OR IN CONNECTION WITH SURGICAL IMPLANTS OR AS CRITICAL COMPONENTS IN ANY LIFE SUPPORT SYSTEMS WHOSE FAILURE TO PERFORM CAN REASONABLY BE EXPECTED TO CAUSE SIGNIFICANT INJURY TO A HUMAN.

(2) IN ANY APPLICATION, INCLUDING THE ABOVE, RELIABILITY OF OPERATION OF THE SOFTWARE PRODUCTS CAN BE IMPAIRED BY ADVERSE FACTORS, INCLUDING BUT NOT LIMITED TO FLUCTUATIONS IN ELECTRICAL POWER SUPPLY, COMPUTER HARDWARE MALFUNCTIONS, COMPUTER OPERATING SYSTEM SOFTWARE FITNESS, FITNESS OF COMPILERS AND DEVELOPMENT SOFTWARE USED TO DEVELOP AN APPLICATION, INSTALLATION ERRORS, SOFTWARE AND HARDWARE COMPATIBILITY PROBLEMS, MALFUNCTIONS OR FAILURES OF ELECTRONIC MONITORING OR CONTROL DEVICES, TRANSIENT FAILURES OF ELECTRONIC SYSTEMS (HARDWARE AND/OR SOFTWARE), UNANTICIPATED USES OR MISUSES, OR ERRORS ON THE PART OF THE USER OR APPLICATIONS DESIGNER (ADVERSE FACTORS SUCH AS THESE ARE HEREAFTER COLLECTIVELY TERMED “SYSTEM FAILURES”). ANY APPLICATION WHERE A SYSTEM FAILURE WOULD CREATE A RISK OF HARM TO PROPERTY OR PERSONS (INCLUDING THE RISK OF BODILY INJURY AND DEATH) SHOULD NOT BE RELIANT SOLELY UPON ONE FORM OF ELECTRONIC SYSTEM DUE TO THE RISK OF SYSTEM FAILURE. TO AVOID DAMAGE, INJURY, OR DEATH, THE USER OR APPLICATION DESIGNER MUST TAKE REASONABLY PRUDENT STEPS TO PROTECT AGAINST SYSTEM FAILURES, INCLUDING BUT NOT LIMITED TO BACK-UP OR SHUT DOWN MECHANISMS. BECAUSE EACH END-USER SYSTEM IS CUSTOMIZED AND DIFFERS FROM NATIONAL INSTRUMENTS' TESTING PLATFORMS AND BECAUSE A USER OR APPLICATION DESIGNER MAY USE NATIONAL INSTRUMENTS PRODUCTS IN COMBINATION WITH OTHER PRODUCTS IN A MANNER NOT EVALUATED OR CONTEMPLATED BY NATIONAL INSTRUMENTS, THE USER OR APPLICATION DESIGNER IS ULTIMATELY RESPONSIBLE FOR VERIFYING AND VALIDATING THE SUITABILITY OF NATIONAL INSTRUMENTS PRODUCTS WHENEVER NATIONAL INSTRUMENTS PRODUCTS ARE INCORPORATED IN A SYSTEM OR APPLICATION, INCLUDING, WITHOUT LIMITATION, THE APPROPRIATE DESIGN, PROCESS AND SAFETY LEVEL OF SUCH SYSTEM OR APPLICATION.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Compliance

Electromagnetic Compatibility Information

This hardware has been tested and found to comply with the applicable regulatory requirements and limits for electromagnetic compatibility (EMC) as indicated in the hardware's Declaration of Conformity (DoC)[1]. These requirements and limits are designed to provide reasonable protection against harmful interference when the hardware is operated in the intended electromagnetic environment. In special cases, for example when either highly sensitive or noisy hardware is being used in close proximity, additional mitigation measures may have to be employed to minimize the potential for electromagnetic interference.

While this hardware is compliant with the applicable regulatory EMC requirements, there is no guarantee that interference will not occur in a particular installation. To minimize the potential for the hardware to cause interference to radio and television reception or to experience unacceptable performance degradation, install and use this hardware in strict accordance with the instructions in the hardware documentation and the DoC[1].

If this hardware does cause interference with licensed radio communications services or other nearby electronics, which can be determined by turning the hardware off and on, you are encouraged to try to correct the interference by one or more of the following measures:

- Reorient the antenna of the receiver (the device suffering interference).
- Relocate the transmitter (the device generating interference) with respect to the receiver.
- Plug the transmitter into a different outlet so that the transmitter and the receiver are on different branch circuits.

Some hardware may require the use of a metal, shielded enclosure (windowless version) to meet the EMC requirements for special EMC environments such as, for marine use or in heavy industrial areas. Refer to the hardware's user documentation and the DoC[1] for product installation requirements.

When the hardware is connected to a test object or to test leads, the system may become more sensitive to disturbances or may cause interference in the local electromagnetic environment.

Operation of this hardware in a residential area is likely to cause harmful interference. Users are required to correct the interference at their own expense or cease operation of the hardware.

Changes or modifications not expressly approved by National Instruments could void the user's right to operate the hardware under the local regulatory rules.

[1] The Declaration of Conformity (DoC) contains important EMC compliance information and instructions for the user or installer. 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.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Contents

About This Manual

Related Documentation ix

Chapter 1
Introduction and Installation

About the NI 951x Drive Interface Modules 1-1
- Features 1-1
- Hardware 1-1

What You Need to Get Started 1-2
- Using the NI 951x Modules in Scan Interface Mode 1-2
- Using the NI 951x Modules in LabVIEW FPGA Interface Mode 1-3

Safety Information 1-3
- Special Conditions for Marine Applications 1-3

Optional Equipment 1-4

Chapter 2
Hardware Overview

NI 951x Connections 2-1
- NI 9512 Connections 2-2
- NI 9514 Connections 2-5
- NI 9516 Connections 2-7

User Connectors 2-9
- NI 9512 Connectors 2-9
- NI 9514 Connectors 2-12
- NI 9516 Connectors 2-14

LED Indicators 2-15
- Axis Status 2-15
- Encoder Active 2-16
- Limit Active 2-16
- Axis Fault 2-16

Chapter 3
Signal Connections

Power Connections 3-4

Command Signals 3-4
- Stepper Command Signals 3-4
  - Step (CW)± and Direction (CCW)± 3-4
- Servo Command Signals 3-6
  - Drive Command Output 3-6
  - Drive Command COM 3-6

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Additional Drive Signals 3-6
Drive Enable 3-6
Motion I/O Signals 3-8
Limit and Home Inputs 3-8
Limit and Home Input Circuit 3-8
Encoder Inputs 3-10
Encoder Phase A/Phase B 3-10
Encoder Index 3-11
Encoder Input Circuit 3-11
Position Capture Input and Position Compare Output 3-12
Digital I/O Signals 3-13
Digital Inputs 3-13
Digital Outputs 3-15

Chapter 4
Accessory and Cable Connections
NI 951x Connection Accessories 4-1
37-Pin Terminal Block Pin Assignments 4-1
Signal Connection Recommendations 4-4
General Connection Recommendations 4-4
Limit and Digital Input Connection Recommendations 4-4
Encoder Connection Recommendations 4-5
Connecting Optional Signals 4-6
Connecting a Brake Signal 4-6

Appendix A
Specifications

Appendix B
Position Command Connections

Appendix C
Technical Support and Professional Services

Glossary

Index

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

About This Manual

This manual describes the electrical and mechanical aspects of the National Instruments 951x C Series drive interface modules and contains information concerning installation and operation.

Related Documentation

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

- Operating Instructions for the controller and modules (shipped with the hardware and available from `ni.com/manuals`)
- *NI-Motion Help*—Contains information about motion programming concepts and the NI-Motion architecture. Access the *NI-Motion Help* by going to **Start»All Programs» NI-Motion»Documentation**.
- *LabVIEW NI SoftMotion Module Help*—Use this help file to learn about using NI SoftMotion in LabVIEW including information about function blocks and using NI SoftMotion with the LabVIEW Project. To access this help file from LabVIEW, select **Help»Search the LabVIEW Help**, then expand the *LabVIEW NI SoftMotion Module* book on the **Contents** tab.
- *LabVIEW Help*—Contains LabVIEW, LabVIEW Real-Time Module, and LabVIEW FPGA Module programming concepts, instructions, and reference information. Access the *LabVIEW Help* by selecting **Help»Search the LabVIEW Help** from within LabVIEW.
- *Getting Started with NI 951x C Series Drive Interface Modules and LabVIEW*—Use this document as a tutorial to learn how to install and use NI 951x modules with the LabVIEW NI SoftMotion Module. Access this document by selecting **Start»All Programs» National Instruments»LabVIEW»LabVIEW Manuals» Getting_Started_NI_951x_Modules_LabVIEW.pdf**.
- *Getting Started with NI 9512 C Series Drive Interface Modules and P7000 Series Stepper Drives*—Use this document as a tutorial to learn how use NI 9512 modules with the P7000 series stepper drives and stepper motors available from NI. Access this document by selecting **Start»All Programs»National Instruments»LabVIEW»LabVIEW Manuals» Getting_Started_NI_9512_P7000.pdf**.
- *Getting Started with NI 9512 C Series Drive Interface Modules and AKD Analog Servo Drives*—Use this document to learn how use NI 9512 modules with the AKD analog servo drives and AKM servo motors available from NI. Access this document by selecting **Start»All Programs»National Instruments»LabVIEW»LabVIEW Manuals» Getting_Started_NI_9512_AKD.pdf**.
- *Getting Started with NI 9514/16 C Series Drive Interface Modules and AKD Analog Servo Drives*—Use this document to learn how use NI 9514 and NI 9516 modules with the AKD analog servo drives and AKM servo motors available from NI. Access this document by selecting **Start»All Programs»National Instruments»LabVIEW»LabVIEW Manuals» Getting_Started_NI_9514_NI_9516_AKD.pdf**.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

1 Introduction and Installation

This chapter includes information about the features of the National Instruments 9512, 9514, and 9516 drive interface modules.

Note The remainder of this document will refer to these modules collectively as NI 951x modules.

About the NI 951x Drive Interface Modules

The NI 951x drive interface modules are a family of C Series motion modules. These modules enable advanced motion with configuration and programming using NI LabVIEW.

Features

The NI 951x modules provide servo or stepper drive interface signals for a single axis, a full set of motion I/O including inputs for a home switch and limit switches, incremental encoder inputs for position feedback, and 0 to 30 V digital input and digital output lines. Refer to Chapter 3, *Signal Connections*, for more information about the signals available on each module.

- The NI 9512 is a single-axis stepper or position command drive interface module with incremental encoder feedback.

Note Refer to Appendix B, *Position Command Connections*, for information about using the NI 9512 module with position command servo drives.

- The NI 9514 is a single-axis servo drive interface module with incremental encoder feedback.
- The NI 9516 is a single-axis servo drive interface module with dual incremental encoder feedback.

Hardware

The NI 951x drive interface modules include a processor to run the spline interpolation engine and patented NI step generation algorithm or *PID control loop*/*PIVff control loop*. Working together they produce smoother motion resulting in precise motion control.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

What You Need to Get Started

Using the NI 951x Modules in Scan Interface Mode

Scan Interface mode enables you to use C Series modules directly from the LabVIEW Real-Time Module. Refer to the *CompactRIO Reference and Procedures (Scan Interface)* book of the *LabVIEW Help* for more information about using C Series modules in Scan Interface mode.

To set up and use the NI 951x drive interface modules in Scan Interface mode, you must have the following items:

☐ The following software packages and documentation:
- LabVIEW NI SoftMotion Module
- LabVIEW Development System
- LabVIEW Real-Time Module
- NI-RIO driver software

Tip Refer to the software documentation for installation instructions.

☐ The following hardware and documentation:
- NI 9512, NI 9514, or NI 9516 drive interface module
- External power supply

Note Refer to the *Power Requirements* section of Appendix A, *Specifications*, for power supply requirements.

- CompactRIO controller and chassis that support the RIO Scan Interface

or

- NI 9144 distributed chassis

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Using the NI 951x Modules in LabVIEW FPGA Interface Mode

LabVIEW FPGA Interface mode enables you to use C Series modules from LabVIEW FPGA VIs. Refer to the *CompactRIO Reference and Procedures (FPGA Interface)* book of the *LabVIEW Help* for more information about using C Series modules in LabVIEW FPGA Interface mode.

To set up and use the NI 951x drive interface modules in LabVIEW FPGA Interface mode, you must have the following items:

☐ The following software packages and documentation:
- (Optional) LabVIEW NI SoftMotion Module
- LabVIEW Development System
- LabVIEW Real-Time Module
- LabVIEW FPGA Module
- NI-RIO driver software

Tip Refer to the software documentation for installation instructions.

☐ The following hardware and documentation:
- NI 9512, NI 9514, or NI 9516 drive interface module
- External power supply

Note Refer to the *Power Requirements* section of Appendix A, *Specifications*, for power supply requirements.

- CompactRIO controller and chassis

Safety Information

Special Conditions for Marine Applications

Some modules are Lloyd's Register (LR) Type Approved for marine applications. To verify Lloyd's Register certification, visit `ni.com/certification` and search for the LR certificate, or look for the Lloyd's Register mark on the module.

Caution To meet radio frequency emission requirements for marine applications, use shielded cables and install the system in a metal enclosure. Suppression ferrites must be installed on power supply inputs near power entries to modules and controllers. Power supply and module cables must be separated on opposite sides of the enclosure and must enter and exit through opposing enclosure walls.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Optional Equipment

National Instruments offers several options for connecting NI 951x drive interface modules to external stepper drives or servo amplifiers including the following:

- **NI 9512-to-P7000 Stepper Drives Connectivity Bundle**—Connects the NI 9512 to the P70530 or P70360 stepper drives available from NI. (NI part number 780552-01)
- **NI 9514/16 to AKD Cable**—Connects the NI 9514 or NI 9516 to the AKD servo drive and AKM brushless servo motors available from NI.
  (NI part number 781524-01)
- **NI 9512 to AKD Cable**—Connects the NI 9512 to the AKD servo drive and AKM brushless servo motors available from NI.
  (NI part number 781525-01)
- **NI 951x Cable and Terminal Block Bundle**—Connects the NI 951x module with the 37-pin spring terminal blocks.
  (NI part number 780553-01)
- **DSUB and MDR Solder Cup Connectors**—Simplifies custom cable creation.
  NI part number for DSUB connector: 780549-01
  NI part number for MDR connector: 780551-01
- **DSUB to Pigtails Cable and MDR to Pigtails Cable**—Simplifies custom cable creation.
  NI part number for DSUB cable: 193412-04
  NI part number for MDR cable: 193413-04

Caution Do *not* use the recommended module power supplies to power a drive. Check your drive documentation for drive power supply requirements.

- +24 V DC power supply

Note Refer to the National Instruments Web site at `ni.com` for available power supplies.

Refer to Chapter 4, *Accessory and Cable Connections*, for cable and terminal block pin assignments. For additional information about these and other available products refer to the National Instruments Web site at `ni.com`, or call your National Instruments sales representative.

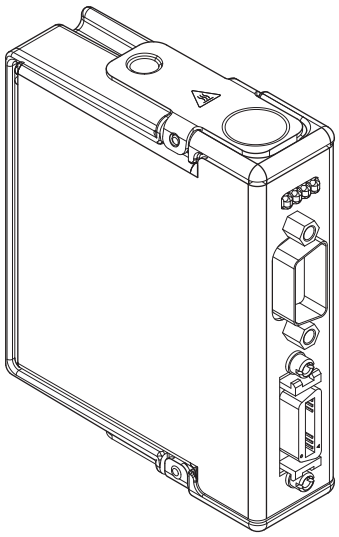
Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

2

Hardware Overview

This chapter presents an overview of the National Instruments 951x drive interface module hardware, including connections and connector pin assignments. The following figure shows the NI 951x module.

Figure 2-1. NI 951x Module



NI 951x Connections

This section contains connection information for each drive interface module, including connection diagrams for a complete system setup.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

NI 9512 Connections

National Instruments offers several options for connecting the NI 9512 to stepper or position command servo drives. Refer to Table 2-1 for available NI 9512 connection options.

Table 2-1. NI 9512 Connection Options

Drive	Connection Option
NI ISM-7400/7401/7402 NI SMD-7610 NI SMD-7611/7612 NI SMD-7620/7621	Direct Connectivity to NI ISM and NI SMD stepper drives Go to `ni.com/info` and enter `stepper` for installation and configuration information for NI ISM and NI SMD stepper drives.
AKD Analog Servo	NI 9512 to AKD Drive Cable (NI part number 781525-01) **Note**: Refer to *Getting Started with NI 9512 C Series Drive Interface Modules and AKD Analog Servo Drives*, available by selecting **Start»All Programs»National Instruments»LabVIEW»LabVIEW Manuals»Getting_Started_NI_9512_AKD.pdf** and on `ni.com/manuals`, for information about connecting and using the NI 9512 module with AKD analog servo drives and AKM brushless servo motors available from NI.
Mitsubishi MR-J2 or MR-J3	NI 9930M Motion Control Accessory (NI part number 781824-01) **Note**: Refer to *NI 9930 Motion Control Accessories User Guide*, available by selecting **Start»All Programs»National Instruments»LabVIEW»LabVIEW Manuals»NI_9930_Motion_Control_Accessories_User_Guide.pdf** and on `ni.com/manuals`, for information about connecting and using the NI 9512 module with the referenced Mitsubishi, Panasonic, and Yaskawa servo drives.
Panasonic Minas-A or Minas-A5	NI 9930P Motion Control Accessory (NI part number 781823-01) **Note**: Refer to *NI 9930 Motion Control Accessories User Guide*, available by selecting **Start»All Programs»National Instruments»LabVIEW»LabVIEW Manuals»NI_9930_Accessories_User_Guide.pdf** and on `ni.com/manuals`, for information about connecting and using the NI 9512 module with the referenced Mitsubishi, Panasonic, and Yaskawa servo drives.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Table 2-1. NI 9512 Connection Options (Continued)

Drive	Connection Option
Yaskawa Sigma-II or Sigma-V	NI 9930Y Motion Control Accessory (NI part number 781822-01) **Note**: Refer to *NI 9930 Motion Control Accessories User Guide*, available by selecting **Start»All Programs»National Instruments»LabVIEW»LabVIEW Manuals» NI_9930_Accessories_User_Guide.pdf** and on `ni.com/manuals`, for information about connecting and using the NI 9512 module with the referenced Mitsubishi, Panasonic, and Yaskawa servo drives.
Other third-party stepper or p-command servo drive	NI 951x cable and terminal block bundle (NI part number 780553-01) **Note**: Refer to Appendix B, *Position Command Drive Signals*, for information about connecting and using the NI 9512 module with other p-command servo drives.

Complete the following steps to connect the NI 9512 stepper drive interface module to drives and other I/O:

1. Install the module in the chassis as specified in the chassis documentation.

Note Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for information about chassis, slot, or software restrictions.

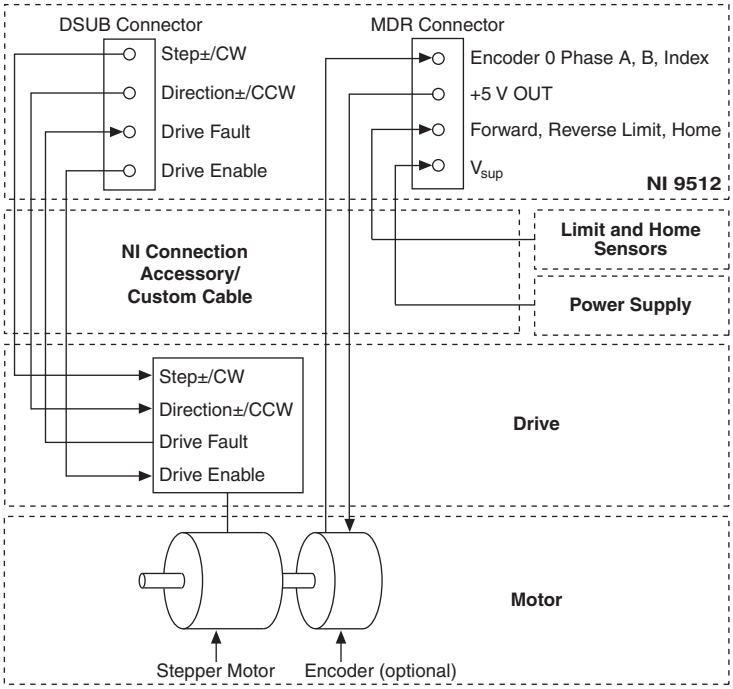
2. Connect the module to a drive and other I/O using on of the connection options in Table 2-1.
3. Connect the NI 9512 module to an external power supply.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 2-2 shows a simplified connection diagram.

Caution Do *not* connect anything to pins marked Reserved.

Figure 2-2. NI 9512 Connection Diagram

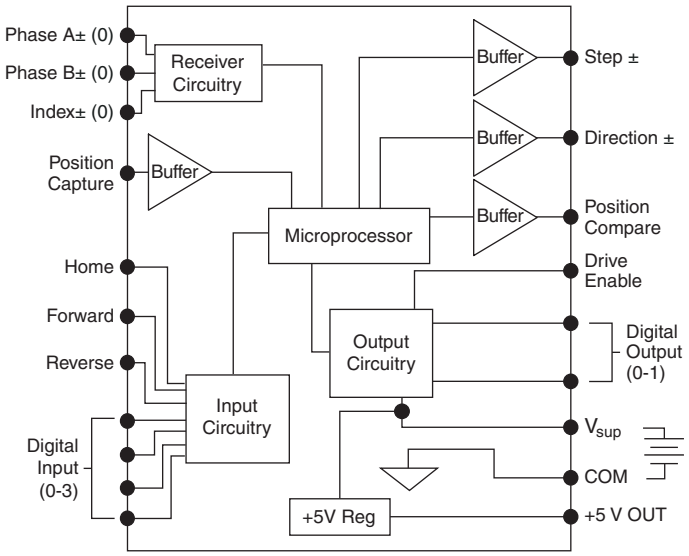


Note The NI 9512 requires an external power supply. You can connect the external power supply to the V_{sup} input provided on the DSUB or MDR connector. Do not connect more than one external power supply to the module.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 2-3 shows the NI 9512 block diagram. Refer to Chapter 3, *Signal Connections*, for more information about the individual signals and connecting devices to the module.

Figure 2-3. NI 9512 Block Diagram



NI 9514 Connections

Complete the following steps to connect the NI 9514 drive interface module to drives and other I/O:

1. Install the module in the chassis as specified in the chassis documentation.

Note Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for information about chassis, slot, or software restrictions.

2. Connect the module to a drive and other I/O using the NI 9514/16 to AKD cable, the NI 951x Cable and Terminal Block Bundle, or a custom cable for direct connectivity to third-party drives.

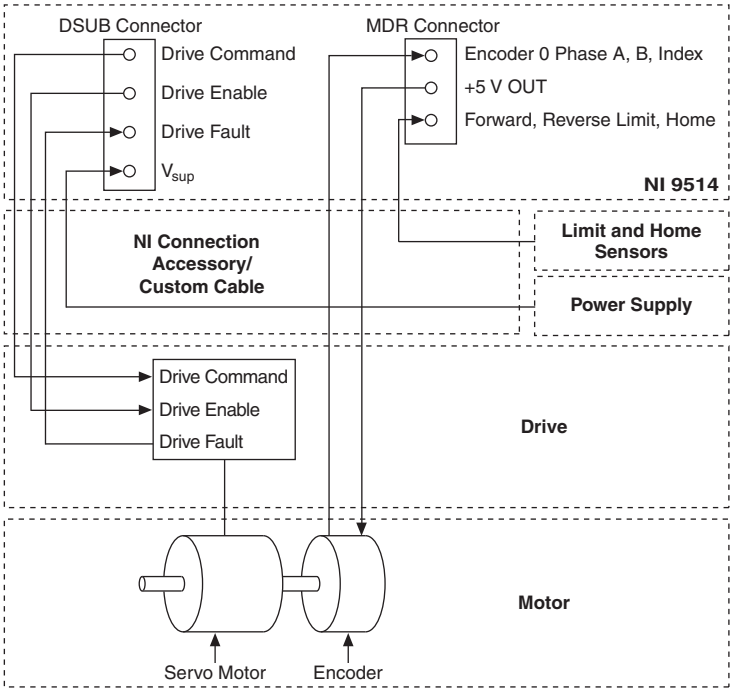
Tip NI offers AKD analog servo drives and matched servo motors. Refer to *Getting Started with NI 9514/16 C Series Drive Interface Modules and AKD Analog Servo Drives* for installation and configuration information. Refer to the *Getting Started with NI 951x C Series Drive Interface Modules and LabVIEW* for information about using the NI 9514 with other devices.

3. Connect the NI 9514 module to an external power supply.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 2-4 shows a simplified connection diagram.

Figure 2-4. NI 9514 Connection Diagram



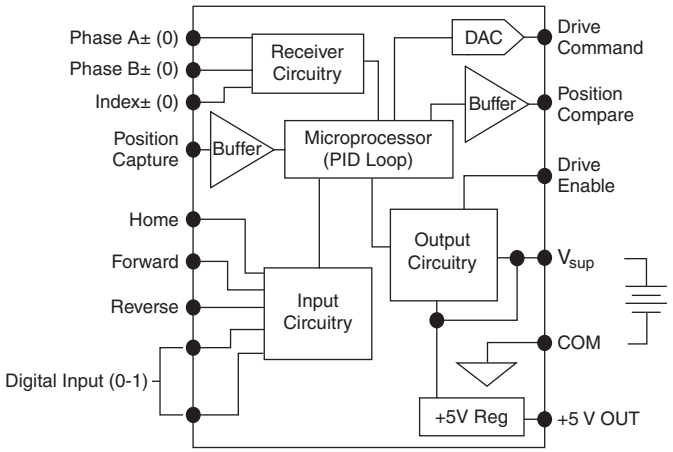
Note The NI 9514 requires an external power supply. You can connect the external power supply to the V_{sup} input provided on the DSUB or MDR connector. Do not connect more than one external power supply to the module.

Caution Do *not* connect anything to pins marked Reserved.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 2-5 shows the NI 9514 block diagram. Refer to Chapter 3, *Signal Connections*, for more information about the individual signals and connecting devices to the module.

Figure 2-5. NI 9514 Block Diagram



NI 9516 Connections

Complete the following steps to connect the NI 9516 drive interface module to drives and other I/O:

1. Install the module in the chassis as specified in the chassis documentation.

Note Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for information about chassis, slot, or software restrictions.

2. Connect the module to a drive and other I/O using the NI 9514/16 to AKD cable, the NI 951x Cable and Terminal Block Bundle, or a custom cable for direct connectivity to third-party drives.

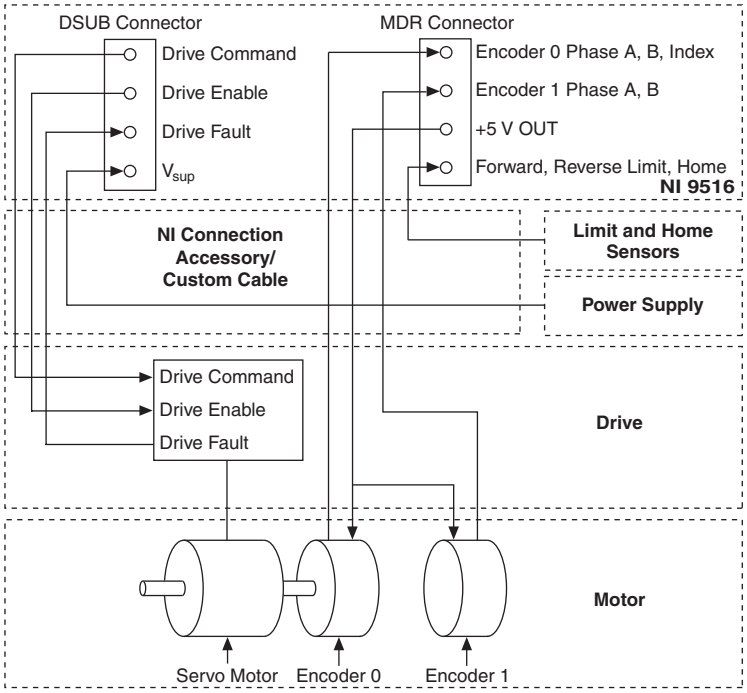
Tip NI offers AKD analog servo drives and matched servo motors. Refer to *Getting Started with NI 9514/16 C Series Drive Interface Modules and AKD Analog Servo Drives* for installation and configuration information. Refer to the *Getting Started with NI 951x C Series Drive Interface Modules and LabVIEW* for information about using the NI 9516 with other devices.

3. Connect the NI 9516 module to an external power supply.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 2-6 shows a simplified connection diagram.

Figure 2-6. NI 9516 Connection Diagram



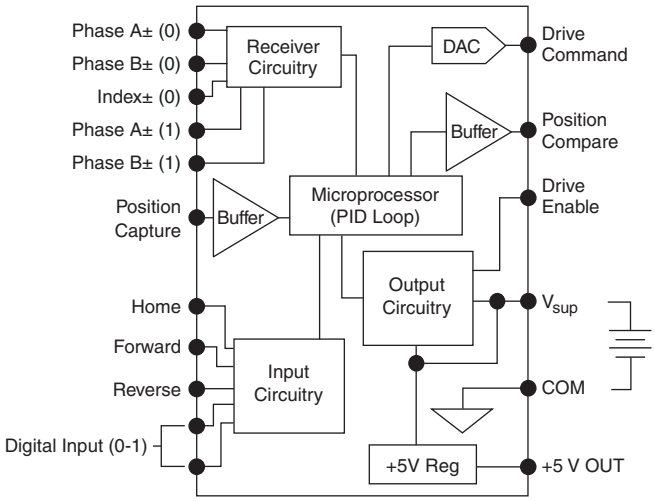
Note The NI 9516 requires an external power supply. You can connect the external power supply to the V_{sup} input provided on the DSUB or MDR connector. Do not connect more than one external power supply to the module.

Caution Do *not* connect anything to pins marked Reserved.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 2-7 shows the NI 9516 block diagram. Refer to Chapter 3, *Signal Connections*, for more information about the individual signals and connecting devices to the module.

Figure 2-7. NI 9516 Block Diagram



User Connectors

The NI 951x has two connectors, a 15-pin DSUB drive interface connector and a 20-pin MDR feedback connector. The 15-pin DSUB includes command signals for interfacing with stepper drives or servo amplifiers, 0 to 30 V general-purpose digital input and digital output lines, and an input for power connection.

The 20-pin MDR connector includes incremental encoder feedback inputs, a +5 V output for encoder power, home, limit, and position compare inputs, an output for position compare, an additional input for power connection, and an additional 0 to 30 V general-purpose digital input line. Refer to Chapter 3, *Signal Connections*, for details about the signals in each connector.

Note The remainder of this document does not distinguish between drives and amplifiers. All references to drives also apply to amplifiers.

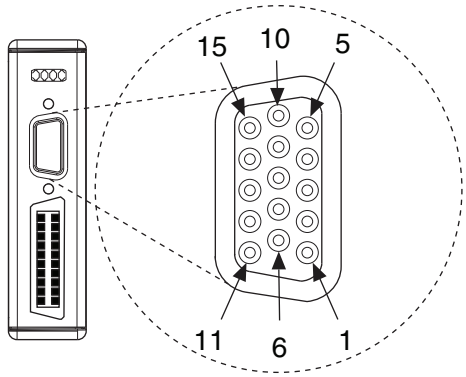
NI 9512 Connectors

Refer to Chapter 4, *Accessory and Cable Connections*, for cabling options and connection accessory pin assignments.

Caution Do *not* connect anything to pins marked Reserved.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

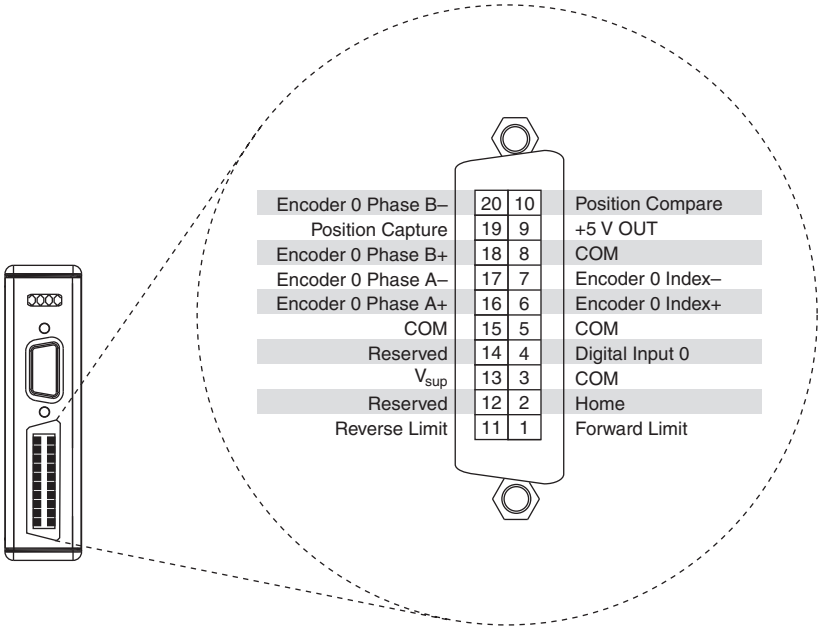
Table 2-2. NI 9512 DSUB Control Connector Pin Assignments

Connector	Pin	Signal
	1	Reserved
	2	Drive Enable
	3	Digital Input 3
	4	Digital Input 2
	5	Digital Output 1
	6	Reserved
	7	COM
	8	Digital Input 1
	9	Direction (CCW)-
	10	Step (CW)-
	11	Digital Output 0
	12	V_{sup}
	13	Direction (CCW)+
	14	COM
	15	Step (CW)+

Note Refer to Appendix B, *Position Command Connections*, for position command signal information and information about connecting the NI 9512 module to position command drives.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 2-8. NI 9512 MDR Connector Pin Assignments



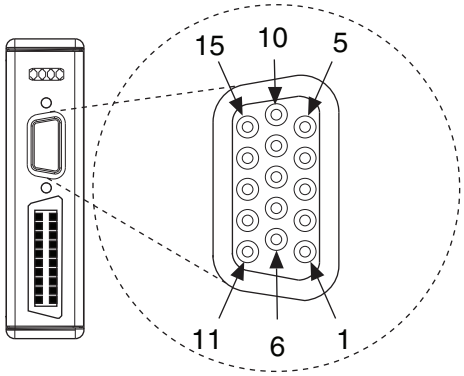
Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

NI 9514 Connectors

Refer to Chapter 4, *Accessory and Cable Connections*, for cabling options and connection accessory pin assignments.

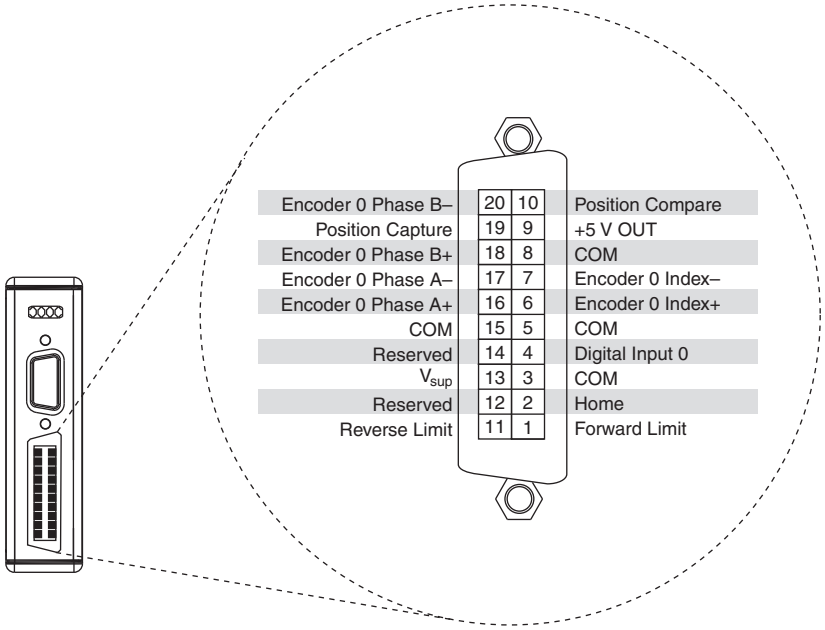
Caution Do *not* connect anything to pins marked Reserved.

Table 2-3. NI 9514 DSUB Control Connector Pin Assignments

Connector	Pin	Signal
	1	Drive Command COM
	2	Drive Enable
	3	Reserved
	4	Reserved
	5	Reserved
	6	Drive Command
	7	COM
	8	Digital Input 1
	9	Reserved
	10	Reserved
	11	Reserved
	12	V_{sup}
	13	Reserved
	14	COM
	15	Reserved

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 2-9. NI 9514 MDR Connector Pin Assignments



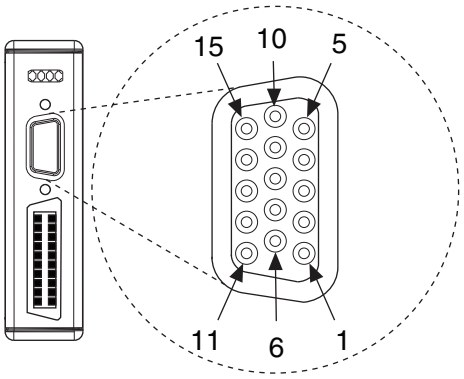
Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

NI 9516 Connectors

Caution Do *not* connect anything to pins marked Reserved.

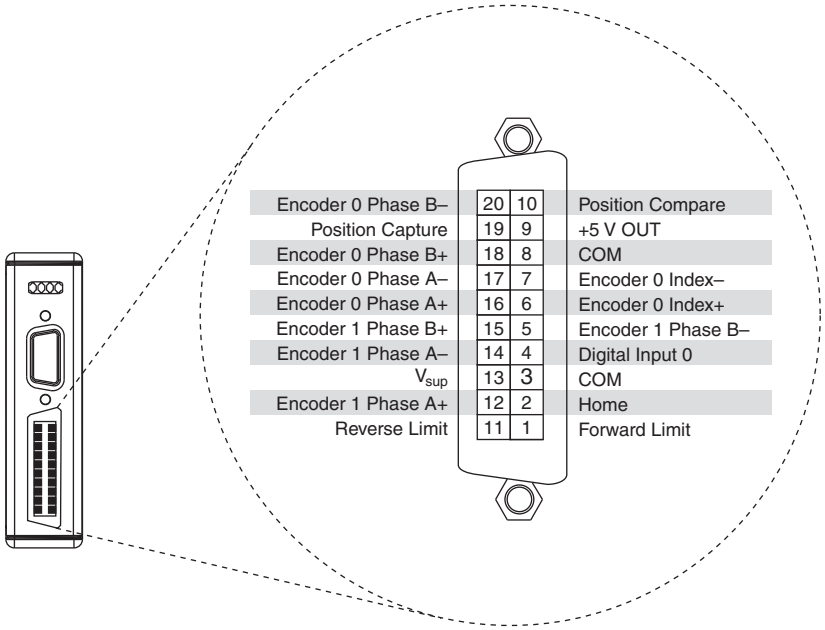
Refer to Chapter 4, *Accessory and Cable Connections*, for cabling options and connection accessory pin assignments.

Table 2-4. NI 9516 DSUB Control Connector Pin Assignments

Connector	Pin	Signal
	1	Drive Command COM
	2	Drive Enable
	3	Reserved
	4	Reserved
	5	Reserved
	6	Drive Command
	7	COM
	8	Digital Input 1
	9	Reserved
	10	Reserved
	11	Reserved
	12	V_{sup}
	13	Reserved
	14	COM
	15	Reserved

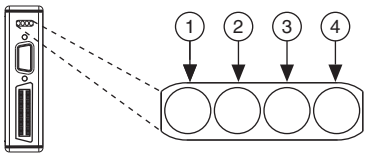
Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 2-10. NI 9516 MDR Connector Pin Assignments



LED Indicators

The NI 951x has four LEDs to display status information.



1	Axis Status (Green)	3	Limit Active (Yellow)
2	Encoder Active (Green)	4	Axis Fault (Red)

Axis Status

The Axis Status LED (green) has three states to display axis status.

- **Off**—The module is in sleep mode or failed to boot correctly. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for troubleshooting information.
- **Flashing**—The module booted up correctly and is functional.
- **Lit**—The module is functional and the drive enable output is active.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Encoder Active

The Encoder Active LED (green) has three states for encoder and V_{sup} status.

- **Off**—The power supply (V_{sup}) is not connected. You must connect a power supply to receive encoder pulses.
- **Flashing**—The power supply (V_{sup}) is connected and the module is receiving encoder pulses.

Note The LED flash rate does not correspond to the rate at which the module receives encoder pulses. For the NI 9516 module, the encoder LED flashes when pulses are received on either Encoder 0 or Encoder 1.

- **Lit**—The power supply (V_{sup}) is connected but the module is not receiving encoder pulses.

Limit Active

The Limit Active LED (yellow) has two states to display the status of the limits and home input.

- **Off**—The power supply (V_{sup}) is not connected, or both the limits and home input are not active.
- **Lit**—The power supply (V_{sup}) is connected and the forward limit, reverse limit, or home input is active.

Axis Fault

The Axis Fault LED (red) has two states to indicate the presence of a fault in the system. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for a list of module faults and troubleshooting information.

- **Off**—No module faults.
- **Lit**—One or more module faults.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3

Signal Connections

This chapter describes how to make input and output signal connections directly to the National Instruments 951x drive interface modules and describes the associated I/O circuitry.

Table 3-1 describes the signals available on the modules.

Table 3-1. NI 951x Signal Reference

Signal	Signal Name	Signal Overview
Stepper Command Signals	Step (CW)+ Step (CW)-	• Configurable Step/Direction or CW/CCW output mode • Configurable single-ended or differential output type • 5 MHz max pulse rate
	Direction (CCW)+ Direction (CCW)-	
Servo Command Signals	Drive Command	• Separate reference to help keep digital noise separate from the analog output • 16-bit analog output • ±10 V range
	Drive Command COM	
Drive Enable	Drive Enable	• Connects to the enable function of the drive • 0 to 30 V output configurable as sinking or sourcing • 100 µs minimum output pulse width

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Table 3-1. NI 951x Signal Reference (Continued)

Signal	Signal Name	Signal Overview
Encoder 0	Encoder 0 Phase A+ Encoder 0 Phase A- Encoder 0 Phase B+ Encoder 0 Phase B- Encoder 0 Index+ Encoder 0 Index-	• Primary encoder for position or velocity feedback • RS-422 differential, compatible with single-ended encoders • 20×10^6 counts/second maximum • 100 ns minimum pulse width (differential inputs) • 400 ns minimum pulse width (single-ended inputs) • Index input used to establish reference position • Digitally filtered
Encoder 1	Encoder 1 Phase A+ Encoder 1 Phase A- Encoder 1 Phase B+ Encoder 1 Phase B-	• Secondary encoder for position or velocity feedback • RS-422 differential, compatible with single-ended encoders • 20×10^6 counts per second maximum • 100 ns minimum pulse width (differential inputs) • 400 ns minimum pulse width (single-ended inputs) • Digitally filtered
+5 V OUT	+5 V OUT	• +5 V supply output generated from the V_{sup} input • Available for encoder power • 150 mA maximum (NI 9512 and NI 9514) • 300 mA maximum (NI 9516)
Limits and Home	Forward Limit Reverse Limit Home	• Connect to switches for system safety • Configurable for sinking or sourcing • 0 to 30 V input range • 100 µs minimum pulse width • Digitally filtered

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Table 3-1. NI 951x Signal Reference (Continued)

Signal	Signal Name	Signal Overview
Position Capture	Position Capture	• High-speed position capture input • 5 V TTL input • 100 ns minimum pulse width • ±2 mA max input current • Digitally filtered
Position Compare	Position Compare	• High-speed position compare output • 5 V TTL output • 100 ns minimum pulse width
Digital Inputs	Digital Input 0 Digital Input 1 Digital Input 2 Digital Input 3	• General-purpose digital inputs • Configurable for sinking or sourcing • 0 to 30 V input range • 100 µs minimum pulse width • Digitally filtered
Digital Outputs	Digital Output 0 Digital Output 1	• General-purpose digital outputs • 0 to 30 V digital outputs configurable as sinking or sourcing • ±100 mA maximum current • 100 µs minimum pulse width
V_{sup}	V_{sup}	• NI 951x power supply input • 19 to 30 V • Connection required to either the DSUB or MDR • 400 mA maximum current
COM	COM	• Reference for digital I/O • Reference for V_{sup} • Reference for +5 V OUT

Note All signals are not available on all modules. Refer to the individual module pinouts in Chapter 2, *Hardware Overview*, for a list of the signals available on each module.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Power Connections

The NI 951x drive interface modules require an external power supply. An onboard regulator generates a +5 V output supply from the V_{sup} input for both internal and external usage. The positive terminal for the power supply must be connected to V_{sup} and the reference must be connected to COM.

Note You can connect the external power supply to the V_{sup} input provided on either DSUB or MDR connectors. Do not connect more than one external power supplies to the module.

Command Signals

The following signals control the stepper or servo drive.

Stepper Command Signals

Step (CW)± and Direction (CCW)±

These signals are the NI 9512 drive interface module stepper command outputs.

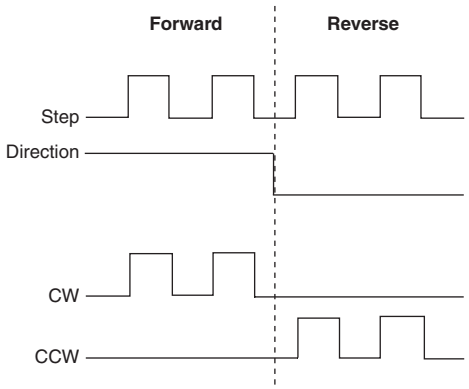
The stepper output mode is software configurable for compatibility with various third-party drives. The NI 9512 module supports both industry standards for stepper command signals—step and direction, or clockwise (CW) and counterclockwise (CCW) pulse outputs, as follows:

- When step and direction mode is configured, each commanded step (or microstep) produces a pulse on the step output. The direction output indicates the commanded direction of motion, either forward or reverse. Refer to Figure 3-1 for an illustration.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

- CW and CCW modes produce pulses on the CW output for forward-commanded motion and pulses on the CCW output for reverse-commanded motion. Refer to Figure 3-1 for an illustration.

Figure 3-1. Step/Direction and CW/CCW Modes



Step and Direction Output Circuit

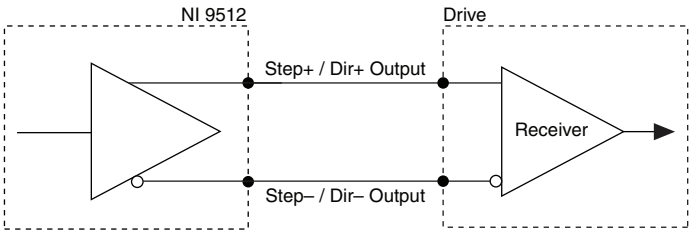
You can configure the active state of both outputs in software as low or high. The active state of the direction output corresponds to a forward direction. The step and direction output circuits can be configured in software for either single-ended or differential output type. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for more information about stepper motor signal settings.

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.

Caution Do *not* connect any unused output lines directly to COM, +5 V OUT, or V_{sup}. Leave all unused output lines unconnected.

When connecting to drives with differential receiver inputs, configure the output type in software to differential and connect as shown in Figure 3-2.

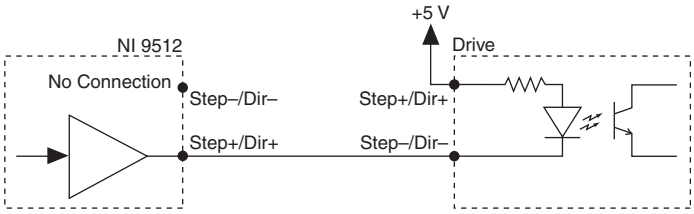
Figure 3-2. Differential Step and Direction Output Connection



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Many stepper drive manufacturers offer opto-isolated inputs for Step (CW)/Direction (CCW) signals. When connecting to opto-isolated inputs, configure the Step output type to single-ended, connect the NI 9512 Step+ output to the negative (cathode) side of the optocoupler input, and leave the Step- output on the NI 9512 disconnected. Connect the positive (anode) side of the drive input to a supply as specified by the drive manufacturer. Figure 3-3 shows a single-ended connection example.

Figure 3-3. Opto-Isolated Step and Direction Output Connection



Caution If the optocoupler input does not include its own current-limiting resistor, you must provide an external resistor in series with the NI 9512 output. To prevent damage to the NI 9512 drive interface module or stepper drive, use a resistor that limits the current to a value below the maximum specifications of the drive interface module and stepper drive. Refer to Appendix A, *Specifications*, for more information.

Note Refer to Appendix B, *Position Command Connections*, for position command signal descriptions and information about connecting the NI 9512 module to drives that support position command mode.

Servo Command Signals

Drive Command Output

The Drive Command output on the servo drive interface modules provide a ±10 V analog output. The Drive Command output features software configurable torque limits and voltage offset.

Drive Command COM

To help keep digital noise separate from the analog output, there is a separate return connection. Use this reference connection as the reference for the Drive Command output when connecting to servo drives instead of using COM (digital I/O reference).

Additional Drive Signals

Drive Enable

Use the Drive Enable output on the NI 951x module to control the enable function of a drive. The enable input on the drive must be active for the drive to acknowledge commands from the module. The Drive Enable signal is active during normal operation and deactivated upon a fault

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

or error condition. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for a list of faults, errors, and other conditions that deactivate the Drive Enable output.

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

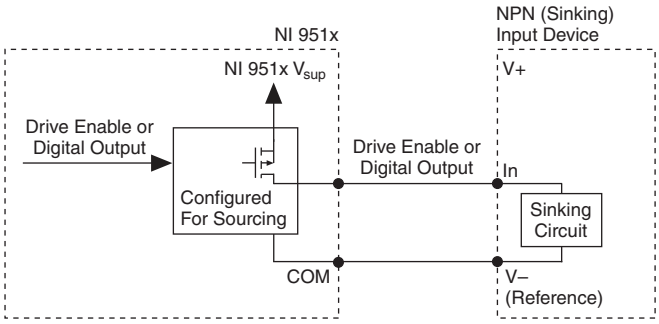
Drive Enable Output Circuit

You can use software to enable and disable the Drive Enable output and to configure the active state of the Drive Enable output to on or off. Refer to the drive documentation to determine the active state of the enable input on the drive. The Drive Enable output type can be configured in software for sinking or sourcing. If the drive has a sinking enable input, configure the output type for the Drive Enable circuit for sourcing. Conversely, if the drive has a sourcing enable input, configure the output type for the Drive Enable circuit for sinking.

Caution Do *not* connect the Drive Enable output to a +5 V input circuit when the Drive Enable output is configured for sourcing.

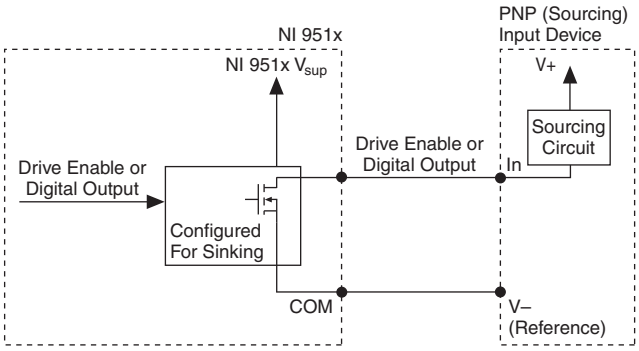
Figure 3-4 shows an example of wiring the output to a sinking input device. Figure 3-5 shows an example of wiring the output to a sourcing input device.

Figure 3-4. Drive Enable Circuit Configured for Sourcing



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 3-5. Drive Enable Circuit Configured for Sinking



Motion I/O Signals

Limit and Home Inputs

The following inputs are available for limit and home functionality on the NI 951x modules:

- Forward Limit Input
- Reverse Limit Input
- Home Input

These inputs are typically connected to limit switches located at physical ends of travel and/or at a specific home position. When enabled, an active transition on the Forward Limit, Reverse Limit, or Home input causes motion on the associated axis to stop. The stop mode is user-configurable in software. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for information about the available stop modes.

The Forward Limit, Reverse Limit, and Home inputs are digitally filtered and have programmable filter frequencies. Active limit and home 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.

Forward Limit, Reverse Limit, and Home inputs 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.

Limit and Home Input Circuit

You can use software to enable and disable Forward Limit, Reverse Limit, and Home inputs and to configure the active state of the signals to on or off. You can also configure the Forward Limit, Reverse Limit, and Home input circuits for current sinking or sourcing output devices.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Tip Refer to the *Signal Connection Recommendations* section of Chapter 4, *Accessory and Cable Connections*, for additional wiring and cabling recommendations.

Figure 3-6 shows an example of wiring the inputs to a sourcing output device. Figure 3-7 shows an example of wiring the inputs to a sinking output device.

Figure 3-6. Limit Input Configured for Sinking

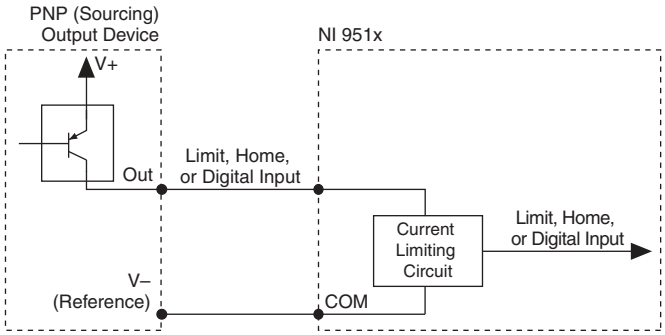


Figure 3-7. Limit Input Configured for Sourcing

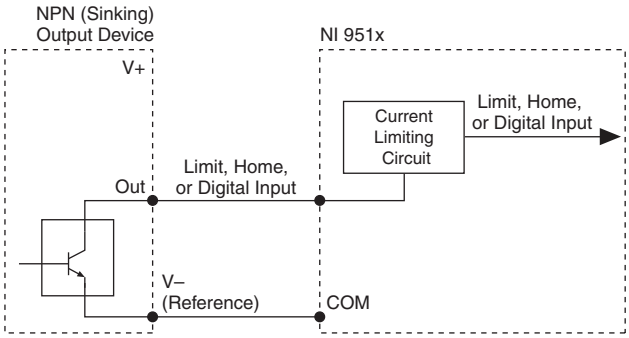


Figure 3-8 shows an example of wiring the inputs to a high-side switch and Figure 3-9 shows an example of wiring the inputs to a low-side switch.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 3-8. High-Side Switch Connected to a Sinking Home or Limit

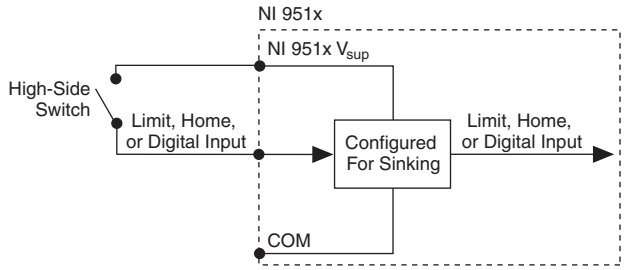
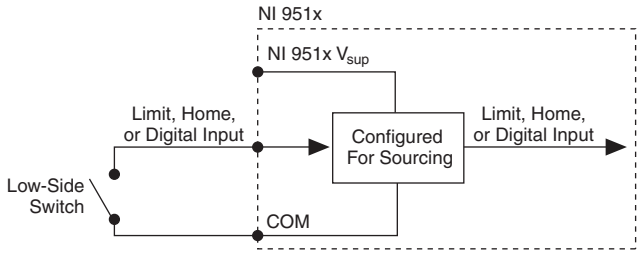


Figure 3-9. Low-Side Switch Connected to a Sourcing Home or Limit



Encoder Inputs

The encoder inputs provide position and velocity feedback information. The encoder channels consist of a Phase A, Phase B, and Index input, as described in the following sections. The NI 9512 and NI 9514 each have a single encoder channel.

The NI 9516 supports two encoder channels that allow for dual-loop feedback, which enhances system stability and precision and provides backlash compensation. The Encoder 0 channel consists of a Phase A, a Phase B, and an Index input. The Encoder 1 channel consists of a Phase A and a Phase B input and does not contain an Index input.

All encoder signals are digitally filtered and provide programmable filter frequencies. The filter settings are based on the software-programmable maximum velocity rate. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for more information about encoder filter settings.

Encoder Phase A/Phase B

Encoder input channel converts pulses on Phase A and Phase B into 32-bit up/down counter values. Pulses are generated by optical, magnetic, laser, or electronic devices that provide two signals, Phase A and Phase B, that are 90 degrees 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 are used to determine position.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

A typical encoder with a specification of N (N = number) lines per unit of measure in revolutions or linear distance, produces $4 \times N$ counts per unit of measure. The count is the basic increment of position in closed-loop motion systems.

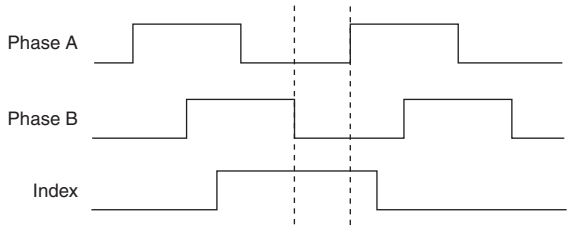
Note To determine your encoder counts per revolution, multiply the specified encoder counts per revolution by four. For example, a 500 line encoder has 2,000 counts per revolution.

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

Encoder Index

The Index input is primarily used to establish a reference position. The Index signal produces a single pulse per revolution. You can use software to capture the Index pulse position and establish a reference zero position for absolute position control. Figure 3-10 shows the single-ended representation of the encoder pulses.

Figure 3-10. Incremental Encoder Phasing Diagram



You can set the index reference criteria in software to change the line state of Phase A and Phase B used in the Index search. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for more information about encoder settings.

Encoder Input Circuit

The NI 951x drive interface modules support RS-422 differential and single-ended inputs for Phase A, Phase B, and Index signals, and provide a +5 V output for encoder power.

You also can set the encoder active state for Phases A, Phase B, and Index to high or low using software. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for more information.

Tip Refer to the *Signal Connection Recommendations* section of Chapter 4, *Accessory and Cable Connections*, for additional wiring and cabling recommendations.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figures 3-11 and 3-12 show simplified schematic diagrams of the encoder input circuit connected to differential and single-ended inputs.

Figure 3-11. Differential Encoder Input Circuit

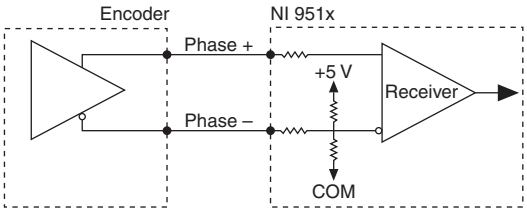
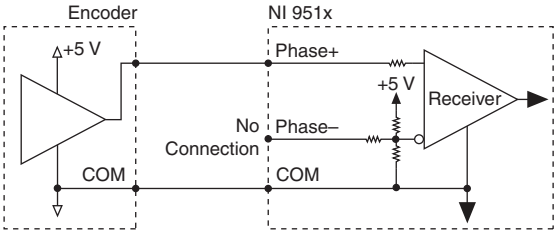


Figure 3-12. Single-Ended Encoder Input Circuit



Position Capture Input and Position Compare Output

The NI 951x drive interface modules have a high-speed Position Capture input and Position Compare output. These signals are useful for high-speed synchronization of motion with actuators, sensors, vision and data acquisition devices, and other components in the complete motion system.

Tip Refer to the *Signal Connection Recommendations* section of Chapter 4, *Accessory and Cable Connections*, for wiring and cabling recommendations.

- **Position Capture**—When enabled, an active transition on a high-speed Position Capture input causes instantaneous position capture of the corresponding encoder count value. You can use this high-speed position capture functionality for applications ranging from simple logging of feedback sensor data to complex camming systems with advance/retard positioning and registration.

Caution If you use an open collector driver for the Position Capture input, provide the voltage equivalent of a logical high during the off state of the open collector driver. A common method to achieve this is by adding a pull-up resistor to the output. Refer to the *Motion I/O* section of Appendix A, *Specifications*, for information about the Position Capture input voltage levels.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

The active edge on the Position Capture input can be set to rising edge or falling edge. In addition, the Position Capture input signal is digitally filtered. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for more information about Position Capture input configuration options.

- **Position Compare**—You can program a Position Compare output to transition when the associated encoder value equals the position compare position. You can use a Position Compare output to directly control actuators or as a trigger to synchronize data acquisition or other functions in the motion control system.

  You can program the Position Compare output for a *single* or for *periodic* positions. The active state of the Position Compare output is configurable in software to high or low, and the action taken at the compare position can be set in software to *pulse*, *set*, or *toggle*. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for more information about Position Compare output functionality and configuration.

Digital I/O Signals

Digital Inputs

The NI 951x drive interface modules have the following digital input signals:

- **Digital Input <0..1>**—The NI 951x drive interface modules include two 5 kHz digital inputs compatible with 0 to 30 V logic outputs.
- **Digital Input <2..3>**—The NI 9512 drive interface module includes two additional 5 kHz digital inputs compatible with 0 to 30 V logic outputs.



Note To use the Drive Fault functionality referenced in the *NI 951x Connections* section of Chapter 2, you must map an available digital input in software. Refer to the *NI SoftMotion LabVIEW Help* for more information about mapping digital inputs and digital outputs to available mappable signals.

You can configure the digital inputs for current sinking or sourcing output devices and set the active state of the inputs in software to on or off. Digital inputs are digitally filtered and have programmable filter frequencies. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for more information about digital input configuration options.



Tip Refer to the *Signal Connection Recommendations* section of Chapter 4, *Accessory and Cable Connections*, for additional wiring and cabling recommendations.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 3-13 shows an example of wiring the digital input signals to a sourcing output device. Figure 3-14 shows an example of wiring the digital input signals to a sinking output device.

Figure 3-13. Digital Input Configured for Sinking

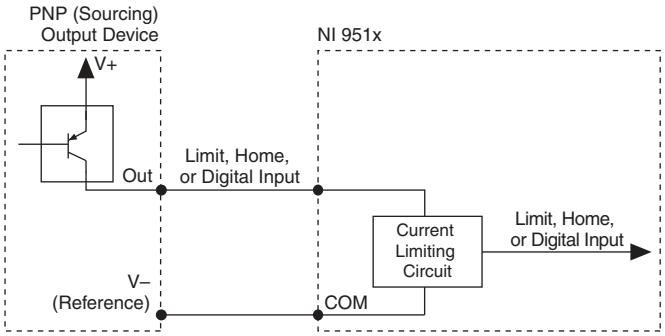


Figure 3-14. Digital Input Configured for Sourcing

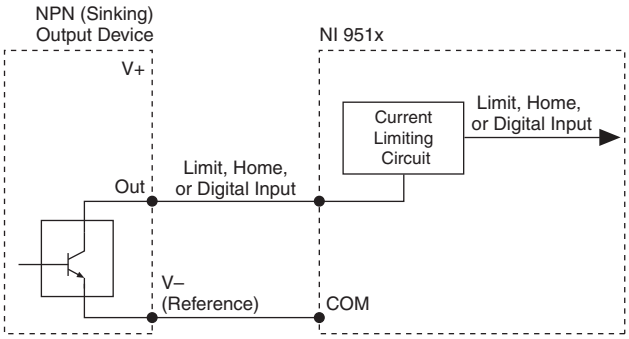
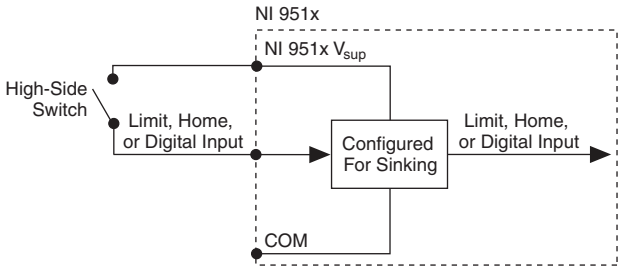


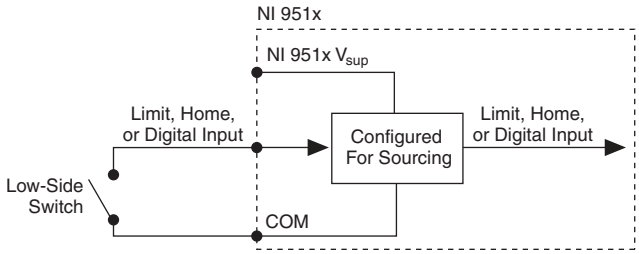
Figure 3-15 shows an example of wiring the digital inputs to a high-side switch. Figure 3-16 shows an example of wiring the digital inputs to a low-side switch.

Figure 3-15. High-Side Switch Connected to a Sinking Digital Input



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 3-16. High-Side Switch Connected to a Sourcing Digital Input



Digital Outputs

The NI 9512 drive interface module also has two general-purpose digital outputs with an output voltage range of 0 to 30 V.

Digital Output Circuit

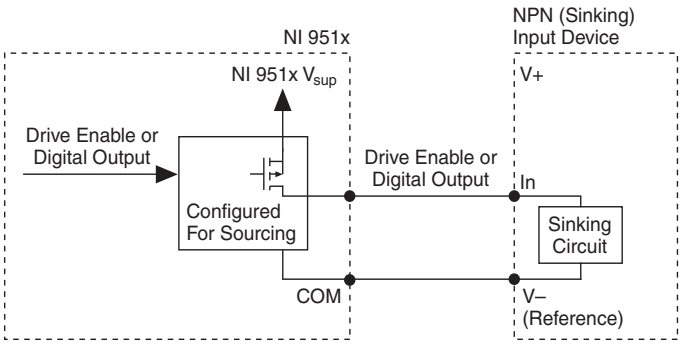
You can configure the active state of the digital outputs in software for on or off and the digital output circuit can be configured in software for sinking or sourcing output type. If you are connecting to sinking inputs, configure the output type to sourcing. Conversely, if you are connecting to sourcing inputs, configure the output type to sinking.

Caution Do *not* connect digital outputs to +5 V input circuitry in either sinking or sourcing configuration.

Tip Refer to the *Signal Connection Recommendations* section of Chapter 4, *Accessory and Cable Connections*, for additional wiring and cabling recommendations.

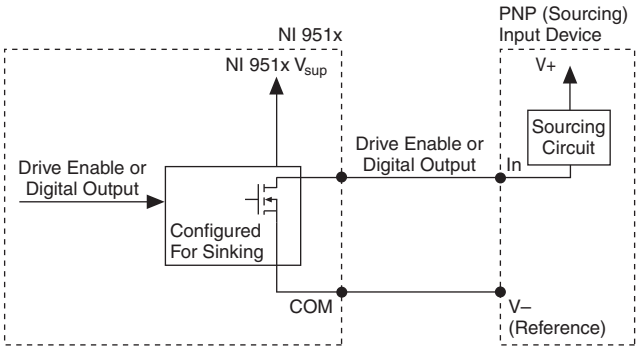
Figure 3-17 shows an example of wiring the digital outputs to a sinking input device.
Figure 3-18 shows an example of wiring the digital outputs to a sourcing input device.

Figure 3-17. Digital Output Circuit Configured for Sourcing



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 3-18. Digital Output Circuit Configured for Sinking



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4

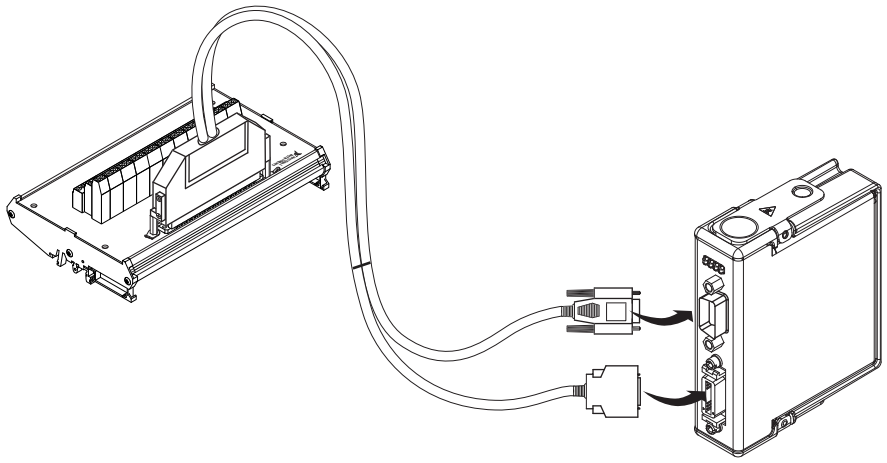
Accessory and Cable Connections

This chapter describes the accessory and cable connections for the National Instruments 951x drive interface modules, including connection diagrams and cable pin assignments, custom cable information, and additional information about software-mappable signals.

NI 951x Connection Accessories

This section contains information about the NI 951x 37-pin terminal blocks and cables, including pin assignments for each module. Figure 4-1 shows the NI 951x module connected to the 37-pin terminal block using the NI 951x to 37-pin cable.

Figure 4-1. NI 951x Module and 37-Pin Terminal Block



37-Pin Terminal Block Pin Assignments

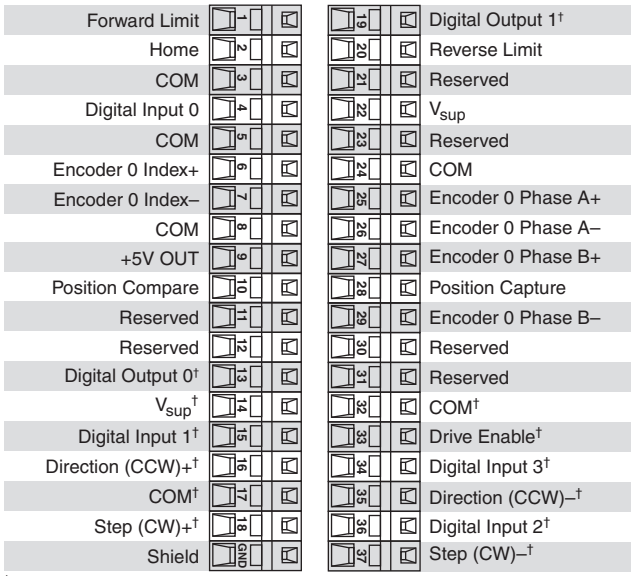
Figure 4-2, Figure 4-3, and Figure 4-4 show the pin assignments for the NI 951x to 37-pin terminal blocks.

Note When connecting only the MDR connector to the terminal block, all DSUB signals on the terminal block are no connects (NC) and when connecting only the DSUB connector to the terminal block, all MDR signals on the terminal block are no connects.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Caution The 37-pin terminal block has separate Vsup and COM terminals for each connector. Make sure you are using the correct Vsup and COM terminals for the connector you are using. All signals associated with the DSUB connector in Figures 4-2, 4-3, and 4-4 are marked with a dagger (†).

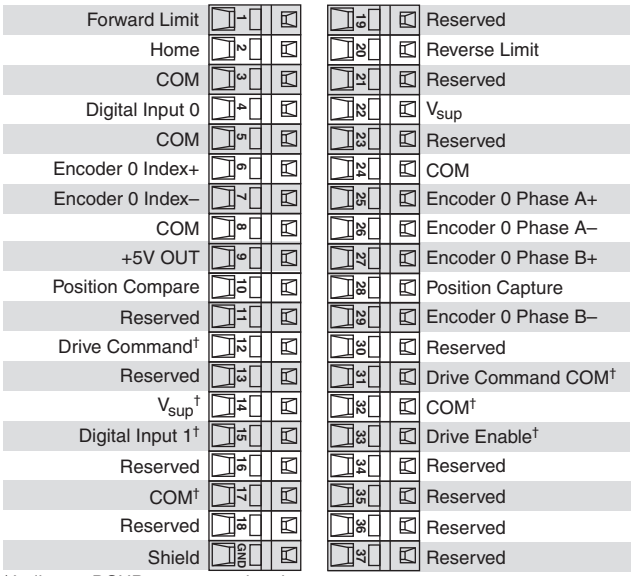
Figure 4-2. NI 9512 37-Pin Terminal Block Pin Assignments



† Indicates DSUB connector signals.

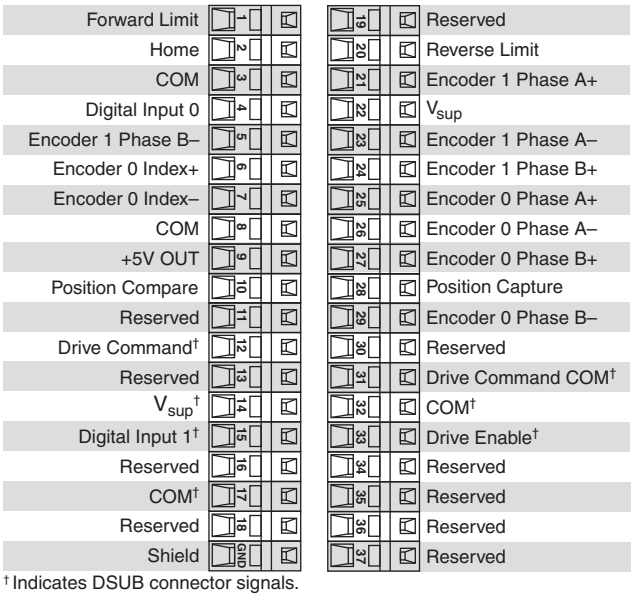
Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 4-3. NI 9514 37-Pin Terminal Block Pin Assignments



† Indicates DSUB connector signals.

Figure 4-4. NI 9516 37-Pin Terminal Block Pin Assignments



† Indicates DSUB connector signals.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Signal Connection Recommendations

This section contains detailed information about signal wiring including precautions and guidelines for error-free operation.

General Connection Recommendations

Use the following guidelines when wiring signals and creating custom cables:

- Keep all signals and their ground connections wired separately from the drive and encoder signal connections. Wiring these signals near each other can cause faulty motion system operation due to signal noise and crosstalk.
- Use shielded cables with a low impedance connection to chassis ground to minimize noise and signal crosstalk.
- Use a separate power supply for the CompactRIO chassis and the NI 951x module(s) to isolate the I/O from the controller.
- Tie the V_{sup} cable shield to chassis ground at the module side only.
- Route wires along the machine frame to reduce high frequency noise.
- Add clamp-on ferrites to cables to further reduce emissions.
- Add a balun to the power cable to attenuate conducted and radiated emissions.

Caution Do *not* exceed the maximum specifications on any input or output. Refer to Appendix A, *Specifications*, for more information.

Limit and Digital Input Connection Recommendations

Use the following additional recommendations when connecting limits and other digital inputs:

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

- 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 reverse or negative end of travel.
- Limit, home, and digital input signals are digitally filtered. Software configurable filters are provided to filter or debounce the input signals. Use shorter filter periods for noise filtering and longer filter periods to debounce the input.

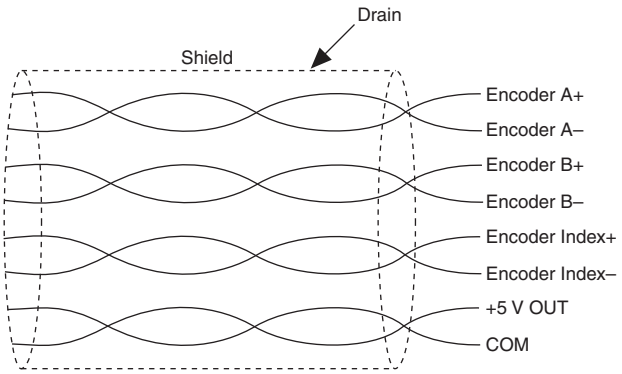
Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Encoder Connection Recommendations

The encoder inputs are connected to incremental decoder/counter circuits. It is very important to minimize noise at this interface. Excessive noise on these encoder input signals may result in loss of counts or extra counts and reduced motion system accuracy. The following additional recommendations apply to encoder signal connections:

- National Instruments strongly recommends you use encoders with differential line driver outputs for all applications. You *must* use differential encoders if the encoder cable length is longer than 3.05 m (10 ft). Shielded, 24 AWG (0.25 mm^2 cross section) wire is the minimum recommended size for the encoder cable.
- Wire encoder signals and their ground connections separately from all other connections. Wiring these signals near the motor drive or other signals can cause positioning errors and faulty operation.
- Cables with twisted pairs and an overall shield are recommended for optimized noise immunity. Figure 4-5 shows twisted pairs in a shielded cable. Unshielded cables can cause noise to corrupt the encoder signals, resulting in lost or additional counts and reduced motion system accuracy.

Figure 4-5. Shielded Twisted Pairs



- Tie the encoder cable shield to COM at the encoder side only.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Connecting Optional Signals

This section contains information about wiring optional NI 951x signals.

Connecting a Brake Signal

The NI 951x digital outputs do not provide enough current to drive typical motor brakes. For this reason, the NI 951x digital outputs must *not* be used to directly control motor brakes. However, you can use the NI 951x digital outputs to control external circuitry that does meet the higher current requirements of motor brakes. Refer to the specifications for the motor brake to determine the maximum current requirements. Use the following recommendations when using an NI 951x digital output to control external circuitry driving the motor brake:

- Do not exceed the maximum current specifications of the NI 951x digital outputs.
- If the same power supply is used for the NI 951x module and the brake circuit, ensure that the power supply meets the maximum requirements of both the NI 951x and the brake circuit.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

A

Specifications

The following specifications are typical for the range -40 to 70 °C unless otherwise noted. All voltages are relative to COM unless otherwise noted.

Stepper Performance (NI 9512 only)

Stepper accuracy ..... 1 full, half, or microstep
Interpolation/spline rate ..... 20 kHz max

Servo Performance (NI 9514, NI 9515, and NI 9516 only)

Module modes of operation ..... Position loop and torque loop
Control loop rate[1] ..... 20 kHz max (position loop)
Servo control loop modes ..... PID, PIVff, and Dual-Loop

Motion Command Signals

Stepper outputs
- Output type ..... Software-selectable: single-ended or differential
- Digital logic levels, single-ended
- High, V_{OH} ..... 5.25 V max
  - Sourcing 20 mA ..... 3.5 V min
  - Sourcing 12 mA ..... 3.7 V min
  - Sourcing 4 mA ..... 3.9 V min
- Low, V_{OL}
  - Sinking 20 mA ..... 0.9 V max
  - Sinking 12 mA ..... 0.7 V max
  - Sinking 4 mA ..... 0.5 V max
- Digital logic levels, differential (Step/Dir(+) - Step/Dir(-))
  - At 20 mA ..... ±1 V min
  - At 12 mA ..... ±1.5 V min
  - At 4 mA ..... ±2 V min

[1] When using a torque loop, the control loop rate depends on the processor speed and communication bus bandwidth. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for more information.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

- Max pulse rate ..... 5 MHz
- Continuous output current on each channel ..... ±20 mA
- Pulse width ..... Approximately 50% of the period, up to 6.4 µs max
- Output mode ..... Software-selectable: step and direction, or CW/CCW
- Active state ..... Software-selectable: high or low

Servo command analog outputs

- Voltage range ..... ±10 V, relative to Drive Command COM
- Resolution ..... 16 bits (0.000305 V/LSB), monotonic
- Max output current ..... ±2 mA

Drive Enable output

- Output type ..... Software-selectable: sinking or sourcing
- Voltage range ..... 0 to 30 V
- V_{sup} input ..... 19 to 30 V
- Continuous output current (I_0) on each channel ..... ±100 mA max
- Output impedance (R_0) ..... 0.3 Ω max
- Output voltage (V_0) sourcing ..... V_{sup} - (I_0R_0)
- Output voltage (V_0) sinking ..... I_0R_0
- Min output pulse width ..... 100 µs
- Active state ..... Software-selectable: on or off

Motion I/O

Encoder 0 and 1 Phase A/B and Encoder 0 Index inputs

- Type ..... RS-422 differential or single-ended inputs
- Digital logic levels, single-ended
  - Voltage ..... -0.25 to 5.25 V
  - High, V_{IH} ..... 2.0 V min
  - Low, V_{IL} ..... 0.8 V max
- Digital logic levels, differential (Phase(+) - Phase(-))
  - Input high range ..... 300 mV to 5 V
  - Input low range ..... -300 mV to -5 V
  - Common-mode voltage[1] ..... -7 to 12 V
- Input current at 5 V ..... ±1 mA

[1] Common-mode voltage is the average of Phase+ and Phase-.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

- Min pulse width[1]
  - Differential ..... 100 ns
  - Single-ended ..... 400 ns
- Max count rate
  - Differential ..... 20×10^6 counts/sec
  - Single-ended ..... 5×10^6 counts/sec

Forward, reverse, and home inputs
- Input type ..... Software-selectable: sinking or sourcing
- Limit or home input configured for sinking
- Digital logic levels, OFF state
  - Input voltage ..... ≤ 5 V
  - Input current ..... ≤ 250 µA
- Digital logic levels, ON state
  - Input voltage ..... 11 to 30 V
  - Input current ..... ≥ 2 mA
- Limit or home input configured for sourcing
- Digital logic levels, OFF state
  - Input voltage ..... 11 to 30 V
  - Input current ..... ≤ 1 mA
- Digital logic levels, ON state
  - Input voltage ..... ≤ 5 V
  - Input current ..... ≥ 2 mA
- Input impedance ..... 30 kΩ ± 5%

Min pulse width[1] ..... 50 µs

Position capture input
- Digital logic levels
  - Voltage ..... -0.25 to 5.25 V
  - High, V_{IH} ..... 2.0 V min
  - Low, V_{IL} ..... 0.8 V max
- Input current
  ($0 \text{ V} \leq V_{in} \leq 4.5 \text{ V}$) ..... ±2 mA max
- Min pulse width[2] ..... 100 ns
- Max capture latency ..... 200 ns
- Capture accuracy ..... ±1 count
- Active edge ..... Software-selectable: rising edge or falling edge

Position compare outputs
- High, V_{OH} ..... 5.25 V max
  - Sourcing 12 mA ..... 3.7 V min

---

[1] Assumes the minimum filter setting. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for more information about filter options.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

- Sourcing 4 mA ..... 3.9 V min
- Low, V_{OL}
  - Sinking 12 mA ..... 0.7 V max
  - Sinking 4 mA ..... 0.5 V max
- Compare mode ..... Software-selectable: single or periodic
- Compare action ..... Software-selectable: set, toggle, or pulse
- Max compare rate (periodic) ..... 5 MHz
- Pulse width (programmable)
  - Min ..... 100 ns
  - Max ..... 1.6 ms
  - Active state ..... Software-selectable: high or low

Digital I/O

Inputs

- Number of inputs
  - NI 9512 4
  - NI 9514 and NI 9516 2
- Input type ..... Software-selectable: sinking or sourcing
- Digital input configured for sinking
- Digital logic levels, OFF state
  - Input voltage ..... ≤ 5 V
  - Input current ..... ≤ 250 µA
- Digital logic levels, ON state
  - Input voltage ..... 11 to 30 V
  - Input current ..... ≥ 2 mA
- Digital input configured for sourcing
- Digital logic levels, OFF state
  - Input voltage ..... 11 to 30 V
  - Input current ..... ≤ 1 mA
- Digital logic levels, ON state
  - Input voltage ..... ≤ 5 V
  - Input current ..... ≥ 2 mA
- Input impedance ..... 30 kΩ ± 5%
- Min pulse width[1] ..... 50 µs

Outputs (NI 9512 only)

- Number of outputs 2
- Output type ..... Software-selectable: sinking or sourcing
- Voltage range ..... 0 to 30 V

[1] Assumes the minimum filter setting. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for more information about filter options.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

V_{sup} input ..... 19 to 30 V
Continuous output current (I_0)
on each channel ..... ±100 mA max
Output impedance (R_0) ..... 0.3 Ω max
Output voltage (V_0) sourcing ..... V_{sup} - (I_0R_0)
Output voltage (V_0) sinking ..... I_0R_0
Min output pulse width ..... 100 µs
Leakage current ..... 200 µA
Active state ..... Software-selectable: on or off
MTBF ..... Contact NI for Bellcore MTBF or MIL-HDBK-217F specifications.

Power Requirements

Power consumption from chassis
Active mode
NI 9512 ..... 925 mW max
NI 9514 ..... 900 mW max
NI 9516 ..... 950 mW max
Sleep mode ..... 0.4 mW max
Thermal dissipation (at 70 °C)
Active mode ..... 1.5 W max
Sleep mode ..... 0.4 mW max
NI 951x Input and Output Characteristics
V_{sup} input ..... 19 to 30 V
NI 9512 ..... 375 mA max
NI 9514 ..... 150 mA max
NI 9516 ..... 150 mA max
+5 V regulated output ..... 5 V ±5%
NI 9512 ..... 150 mA max
NI 9514 ..... 150 mA max
NI 9516 ..... 300 mA max

Physical Characteristics

If you need to clean the module, wipe it with a dry towel.

Note For two-dimensional drawings and three-dimensional models of the C Series module and connectors, visit `ni.com/dimensions` and search by module number.

Weight ..... 155 g (5.5 oz)

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Safety

Safety Voltages

Connect only voltages that are within the following limits.

Channel-to-COM ..... 0 to +30 VDC max, Measurement Category I

Isolation

- Channel-to-channel ..... None
- Channel-to-earth ground
  - Continuous ..... 30 VDC, Measurement Category I
  - Withstand ..... 500 V_{rms}, verified by a 5 s dielectric withstand test

Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as *MAINS* voltage. MAINS is a hazardous live electrical supply system that powers equipment. 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.

Caution Do not connect the NI 951x to signals or use for measurements within Measurement Categories II, III, or IV.

Safety Standards

This product meets 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, CSA 61010-1

Note For UL and other safety certifications, refer to the product label or the *Online Product Certification* section.

Electromagnetic Compatibility

This product meets the requirements of the following EMC standards for electrical equipment for measurement, control, and laboratory use:

- EN 61326-1 (IEC 61326): Class A emissions; Industrial immunity
- EN 55011 (CISPR 11): Group 1, Class A emissions
- AS/NZS CISPR 11: Group 1, Class A emissions
- FCC 47 CFR Part 15B: Class A emissions
- ICES-001: Class A emissions

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Note For the standards applied to assess the EMC of this product, refer to the Online Product Certification section.

Note For EMC compliance, operate this device with double-shielded cables.

CE Compliance CE

This product meets the essential requirements of applicable European Directives as follows:

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EC; Electromagnetic Compatibility Directive (EMC)

Online Product Certification

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

Shock and Vibration

To meet these specifications, you must panel mount the system.

Operating vibration

Random (IEC 60068-2-64) ..... 5 g_{rms}, 10 to 500 Hz

Sinusoidal (IEC 60068-2-6)..... 5 g, 10 to 500 Hz

Operating shock (IEC 60068-2-27) ..... 30 g, 11 ms half sine, 50 g, 3 ms half sine, 18 shocks at 6 orientations

Environmental

Refer to the manual for the chassis you are using for more information about meeting these specifications.

Operating temperature
(IEC 60068-2-1, IEC 60068-2-2) ..... -40 to 70 °C

Storage temperature
(IEC 60068-2-1, IEC 60068-2-2) ..... -40 to 85 °C

Ingress protection ..... IP 40

Operating humidity (IEC 60068-2-56)..... 10 to 90% RH, noncondensing

Storage humidity (IEC 60068-2-56)..... 5 to 95% RH, noncondensing

Pollution Degree (IEC 60664)..... 2

Maximum altitude..... 5,000 m

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Environmental Management

National Instruments is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial to the environment and to NI customers.

For additional environmental information, refer to the *Minimize Our Environmental Impact* web page at `ni.com/environment`. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)



EU Customers At the end of the product life cycle, all products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers, National Instruments WEEE initiatives, and compliance with WEEE Directive 2002/96/EC on Waste and Electronic Equipment, visit `ni.com/environment/weee`.

电子信息产品污染控制管理办法 （中国 RoHS）



中国客户 National Instruments 符合中国电子信息产品中限制使用某些有害物质指令 (RoHS)。关于 National Instruments 中国 RoHS 合规性信息，请登录 `ni.com/environment/rohs_china`。 (For information about China RoHS compliance, go to `ni.com/environment/rohs_china`.)

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

B

Position Command Connections

This appendix contains information about using the NI 9512 drive interface module with drives that support position command mode or pulse command input.

Note If you are using a Mitsubishi MR-J2, Mitsubishi MR-J3, Panasonic Minas-A, Panasonic Minas-A5, Yaskawa Sigma-II, or Yaskawa Sigma-V drive, refer to the *NI 9930 Motion Control Accessories User Guide*, which describes how to use the NI 9512 drive interface module with accessories designed for these drives. This document is available by selecting **Start»All Programs»National Instruments» LabVIEW»LabVIEW Manuals»NI_9930_Accessories_User_Guide.pdf** and on `ni.com/manuals`.

Connecting the NI 9512 to a P-Command Drive

Complete the following steps to connect the NI 9512 drive interface module to p-command drives and other I/O:

1. Install the module in the chassis as specified in the chassis documentation.

Note Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for information about chassis, slot, or software restrictions.

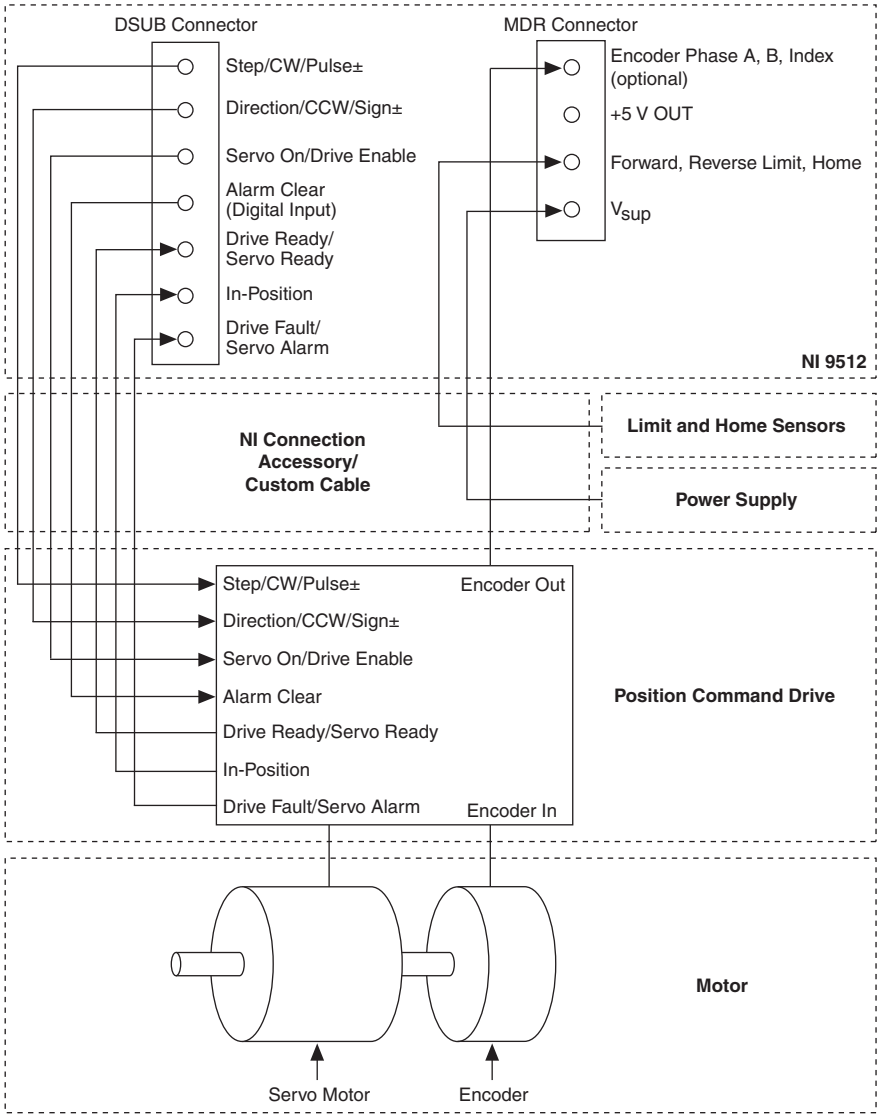
2. Connect the module to a drive and other I/O using the NI 951x 37-pin terminal block and NI 951x 37-pin terminal block cable or a custom cable.

Note Many p-command drive manufacturers refer to the Step± signal as Pulse± and the Direction± signal as Sign±.

Figure B-1 shows a simplified connection diagram.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure B-1. NI 9512 to Position Command Drive Connection Diagram



Note For operation the NI 9512 requires an external power supply. You can connect the external power supply to the V_{sup} input provided on the DSUB or MDR connector. Do not connect more than one external power supply to the module.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3. Map the additional position command drive signals as described in the *Position Command Drive Signals* section of this appendix.

Position Command Drive Signals

This section describes additional signals that are used with position command drives. You can use these signals with your drive if you map the signal functionality to an available digital input or digital output using software. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for more information about mapping digital inputs and digital outputs. Refer to Chapter 3, *Signal Connections*, for information about other NI 9512 module signals.

The following inputs are driven from the drive to provide system status to the module.

- **Servo Alarm/Drive Fault**—Disables the drive in case of a drive error. The module does not generate step and direction outputs when the alarm input is active. The alarm signal is inactive during normal operation.
- **In-Position**—Indicates that the drive has completed the move and has reached the target position.
- **Servo Ready/Drive Ready**—Indicates that the drive is ready or enabled.

The following signal is driven from the module to the position command drive:

- **Alarm Clear**—Clears the alarm or fault outputs on the drive.

Note The Alarm Clear functionality is not mappable in software. Refer to the *NI SoftMotion LabVIEW Help* for information about implementing this functionality using an available digital output.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

C

Technical Support and Professional Services

Log in to your National Instruments ni.com User Profile to get personalized access to your services. Visit the following sections of ni.com for technical support and professional services:

- **Support**—Technical support at ni.com/support includes the following resources:
  - **Self-Help Technical Resources**—For answers and solutions, visit ni.com/support for software drivers and updates, a searchable KnowledgeBase, product manuals, step-by-step troubleshooting wizards, thousands of example programs, tutorials, application notes, instrument drivers, and so on. Registered users also receive access to the NI Discussion Forums at ni.com/forums. NI Applications Engineers make sure every question submitted online receives an answer.
  - **Standard Service Program Membership**—This program entitles members to direct access to NI Applications Engineers via phone and email for one-to-one technical support, as well as exclusive access to self-paced online training modules at ni.com/self-paced-training. All customers automatically receive a one-year membership in the Standard Service Program (SSP) with the purchase of most software products and bundles including NI Developer Suite. NI also offers flexible extended contract options that guarantee your SSP benefits are available without interruption for as long as you need them. Visit ni.com/ssp for more information.

    For information about other technical support options in your area, visit ni.com/services, or contact your local office at ni.com/contact.
- **Training and Certification**—Visit ni.com/training for training and certification program information. You can also register for instructor-led, hands-on courses at locations around the world.
- **System Integration**—If you have time constraints, limited in-house technical resources, or other project challenges, National Instruments Alliance Partner members can help. To learn more, call your local NI office or visit ni.com/alliance.
- **Declaration of Conformity (DoC)**—A DoC is our claim of compliance with the Council of the European Communities using the manufacturer's declaration of conformity. This system affords the user protection for electromagnetic compatibility (EMC) and product safety. You can obtain the DoC for your product by visiting ni.com/certification.
- **Calibration Certificate**—If your product supports calibration, you can obtain the calibration certificate for your product at ni.com/calibration.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

You also can visit the Worldwide Offices section of ni.com/niglobal to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Glossary

Symbol	Prefix	Value
n	nano	10^{-9}
µ	micro	10^{-6}
m	milli	10^{-3}
k	kilo	10^{3}
M	mega	10^{6}

Numbers/Symbols

+5 V OUT — +5 VDC source signal

A

acceleration/deceleration — A measurement of the change in velocity as a function of time.

amplifier — A device that delivers power to operate the motor in response to control signals.

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

C

CCW — counterclockwise—Implies direction of motor rotation.

closed-loop — A control system that uses feedback to achieve control.

COM — Reference signal for digital I/O.

counts — Specified encoder resolution multiplied by four.

crosstalk — A phenomenon by which a signal transmitted on one channel causes an undesired effect on another channel.

CW — clockwise—Implies direction of motor rotation.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

D

dedicated	Assigned to a particular function.
Direction output	Command signal for stepper motors, indicates the commanded direction of motion, either forward or reverse.
drive	Electronic signal amplifier that converts motor control command signals into higher-voltage signals suitable for driving motors.
driver	A hardware device that provides signals or electrical current to activate a transmission line.

E

encoder	A device that translates mechanical motion into electrical signals; used for monitoring position or velocity in a closed-loop system.
encoder resolution	The number of lines per unit of measure. Units can be inches, centimeters, revolutions, and so on.

F

filtering	A type of signal conditioning that removes unwanted noise from the signal being measured.
full-step	The coarsest mode of stepper motor driving that occurs when fully energizing the windings.

H

half-step	A stepper motor mode. For a two phase motor, half-step mode 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.
high	An input or output is high if the voltage is higher than the specified digital logic high level.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

high-side switch	A switch that provides a path to supply when closed.
home switch (input)	A physical position determined by the mechanical system or designer as the reference location for system initialization. Frequently, the home position is also regarded as the zero position in an absolute position frame of reference.

I

incremental encoder	A device that produces two signals, Phase A and Phase B, which are 90 degrees out of phase, allowing for edge counting to provide relative position information.
index	Marker on an encoder that produces a single signal per revolution and is typically used to establish a reference position.

L

limit switch/ end-of-travel position (input)	Sensors that alert the control electronics that the physical end of travel is being approached and that the motion should stop.
low	An input or output is low if the voltage is lower than the specified digital logic low level.
low-side switch	A switch that provides a path to ground when closed.

M

microstep	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.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

N

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.

O

off	An input or output is off when current is not flowing through the input or output circuit.
on	An input or output is on when current is flowing through the input or output circuit.
open-loop	A control system where no external sensors (feedback devices) are used to achieve control of the system.

P

p-command	A command mode used for certain types of servo motor drives that accept step and direction (CW/CCW) information to drive a servo motor.
PID control loop	proportional-integral-derivative control loop—A control method in which the controller output is proportional to the error, the sum of all previous errors, and the rate at which the error is changing. The error is the difference between the observed and the commanded values of the device that is being controlled.
PIVff control loop	proportional-integral-velocity feed forward control loop—A control method in which the controller output is proportional to the error, the sum of all previous errors, and the future trajectory velocity. The error is the difference between the observed and the commanded values of the device that is being controlled.
position capture input	Record position based on an external event.
position compare output	When the encoder reaches a user-specified position, the associated position compare output performs the user-specified action.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

S

servo	Specifies an axis that controls a servo motor.
sinking device	A device that provides a path to ground.
sourcing device	A device that provides a path to supply.
Step output	Command signal for stepper motors, each step produces a pulse on the step output, leading to a step (or microstep) of the motor.
stepper	Specifies an axis that controls a stepper motor.

T

toggle	Changing state between high and low or on and off.
torque	Rotary force.

V

V_{sup}	Power supply input.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Index

Symbols

+5 V OUT signal description (table), 3-2

A

alarm clear output, B-3
alarm input, B-3
axis fault LED, 2-16
axis status LED, 2-15

B

brake signal, connection, 4-6

C

calibration certificate (NI resources), C-1
CCW signal. *See* Direction (CCW) signal
command signals, 3-4
    Direction (CCW), 3-4
    Drive Command COM, 3-6
    Drive Command output, 3-6
    servo drives, 3-6
    Step (CW), 3-4
    stepper drives, 3-4
connections
    digital input signals, 4-5
    Direction (CCW) signal, 3-5
    encoder signals, 4-5
    home, 4-5
    limit signals, 3-8, 4-5
    NI 9512, 2-2
        figure, 2-4
    NI 9514, 2-5
        figure, 2-6
    NI 9516, 2-7
        figure, 2-8
    position capture input, 4-4
    Step (CW) signal, 3-5
connectors
    NI 9512, 2-10
    NI 9514, 2-12
    NI 9516, 2-14
conventions used in the manual, *ix*
CW signal. *See* Step (CW) signal

D

Declaration of Conformity
  (NI resources), C-1
diagnostic tools (NI resources), C-1
digital I/O connectors specifications, A-4
digital I/O signals, 3-13
Digital Input <1..4> signal
    description (table), 3-3
    wiring, 3-8, 3-9, 3-14, 3-15
digital inputs
    connection recommendations, 4-5
    purpose and use, 3-13
    signal descriptions, 3-15
Digital Output <1..2> signal
    description (table), 3-3
digital outputs
    purpose and use, 3-15
Direction (CCW) signal
    connections, 3-5
    description (table), 3-1
    output circuit, 3-5
    purpose and use, 3-4
documentation
    conventions used in manual, *ix*
    NI resources, C-1
    related documentation, *x*
Drive Command COM signal
    description (table), 3-1
    purpose and use, 3-7
Drive Command output specifications, A-2
Drive Command signal
    description (table), 3-1
    purpose and use, 3-6
Drive Enable output specifications, A-2
Drive Enable signal
    description (table), 3-1
    purpose and use, 3-6
drive fault, configuring, 3-13
drive signals, Drive Enable, 3-6
drivers (NI resources), C-1
DSUB connector
    Digital Inputs, 3-13
    Digital Outputs, 3-15

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Direction (CCW), 3-4
Drive Command, 3-6
Drive Command COM, 3-6
Step (CW), 3-4
V_{sup}, 3-4

E

Encoder 0 Index signal
description (table), 3-2
Encoder 0 Phase A signal
description (table), 3-2
Encoder 0 Phase B signal
description (table), 3-2
Encoder 1 Phase A signal
description (table), 3-2
Encoder 1 Phase B signal
description (table), 3-2
encoder active LED, 2-16
Encoder Index signal
purpose and use, 3-11
Encoder Phase A signal
purpose and use, 3-10
Encoder Phase B signal
purpose and use, 3-10
encoder signals
connection recommendations, 4-5
Encoder Index, 3-11
input circuit, 3-11
Phase A, 3-10
Phase B, 3-10
signal descriptions, 3-11
wiring concerns, 4-5
examples (NI resources), C-1

F

feature overview, 1-1
Forward Limit input signal
description (table), 3-2
purpose and use, 3-8

H

hardware requirements, 1-2
help, technical support, C-1
Home input signal
description (table), 3-2
purpose and use, 3-8
home, connection recommendations, 4-4

I

in-position input, B-3
instrument drivers (NI resources), C-1

K

KnowledgeBase, C-1

L

LED indicators
axis fault, 2-16
axis status, 2-16
encoder active, 2-16
limit active, 2-16
limit active LED, 2-16
limit and home inputs
connections, 3-8
Forward Limit input, 3-8
Home input, 3-8
input circuit, 3-8
Reverse Limit input, 3-8
signal descriptions, 3-8
limit signals, connection
recommendations, 4-4

M

MDR connector
Digital Inputs, 3-13
Encoder Index, 3-11
Encoder Phase A, 3-10
Encoder Phase B, 3-10
Forward Limit, 3-8
Home, 3-8
Position Capture, 3-12
Position Compare, 3-13
Reverse Limit, 3-8
V_{sup}, 3-4
motion I/O signals, 3-8

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

N

National Instruments support and services, C-1
NI 9512
- connection diagram (figure), 2-4
- connections, 2-2
- DSUB connector, 2-10
- MDR connector, 2-11

NI 9514
- connection diagram (figure), 2-6
- connections, 2-5
- DSUB connector, 2-12
- MDR connector, 2-13

NI 9516
- connection diagram (figure), 2-8
- connections, 2-7
- DSUB connector, 2-14
- MDR connector, 2-15

NI 951x
- features, 1-1
- requirements for getting started, 1-2

P

physical specifications, A-5
position capture input connection recommendations, 4-4
Position Capture signal
- description (table), 3-3
- overview, 3-13
- purpose and use, 3-13

position command drive signals
- alarm, B-3
- alarm clear, B-3
- in-position, B-3
- servo ready, B-3

Position Compare signal
- description (table), 3-3
- overview, 3-14
- purpose and use, 3-14

power connections, 3-4
power requirement specifications, A-5
programming examples (NI resources), C-1

R

related documentation, *ix*
Reverse Limit input signal
- description (table), 3-2
- purpose and use, 3-8

S

servo drive command signals, 3-6
servo performance specifications, A-1
servo ready input, B-3
signal connections. *See* power connections, command signals, motion I/O signals, and digital I/O signals
software
- requirements, 1-2
- NI resources, C-1

specifications
- digital I/O, A-4
- motion I/O, A-2
- physical, A-5
- power requirements (max), A-5
- servo performance, A-1
- stepper performance, A-1

Step (CW) signal
- connections, 3-5
- description (table), 3-1
- output circuit, 3-5
- purpose and use, 3-4

stepper drive command signals, 3-4
stepper output specifications, A-1
stepper performance specifications, A-1
support, technical, C-1

T

technical support, C-1
terminal block pin assignments, 4-2
training and certification (NI resources), C-1
troubleshooting (NI resources), C-1

V

V_{sup} signal
- connections, 3-4
- description (table), 3-3

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

W

Web resources, C-1
wiring concerns
    digital input signals, 4-4
    encoder signals, 4-5
    home, 4-4
    limit signals, 4-4
    position capture input, 4-4

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP