NI 9514
Servo Drive Interface Module with Encoder Feedback
This document describes how to use the National Instruments 9514 module and includes specifications and pin assignments for the NI 9514. Visit ni.com/info and enter the Info Code rdsoftwareversion to determine which software you need for the modules you are using. For information about installing, configuring, and programming the system, refer to the system documentation. Visit ni.com/info and enter cseriesdoc for information about C Series documentation.

Note The safety guidelines and specifications in this document are specific to the NI 9514. The other components in the system may not meet the same safety ratings and specifications. Refer to the documentation for each component in the system to determine the safety ratings and specifications for the entire system.
Safety Guidelines

Operate the NI 9514 only as described in these operating instructions.

⚠️ Hot Surface  This icon denotes that the component may be hot. Touching this component may result in bodily injury.

Special Conditions for Marine Applications

Some modules are Lloyd’s Register (LR) Type Approved for marine applications. To verify Lloyd’s Register certification, go to 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.
Connecting the NI 9514

The NI 9514 servo drive interface module is part of a family of C Series motion modules. The module provides servo 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 lines. The NI 9514 also includes a processor to run the spline interpolation engine and PID control loop. Working together they produce smoother motion resulting in precise servo motion control.

System Connection

The NI 9514 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 servo amplifiers or drives, a 0 to 30 V general-purpose digital input line, and a 19 to 30 V input for power connection. Refer to Table 1 for the DSUB connector pin assignments.

![Note](image)

The remainder of this document does not distinguish between drives and amplifiers. All references to drives also apply to amplifiers.
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 19 to 30 V input for power connection, and an additional 0 to 30 V general-purpose digital input line. Refer to Figure 2 for the MDR connector pin assignments.

**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.

National Instruments offers several options for connecting the NI 9514 to servo drives. You can use the NI 951x Cable and Terminal Block Bundle to connect to third-party servo drives. Refer to Figure 3 for the 37-pin terminal block pin assignments. Refer to the *NI 951x User Manual*, which you can download from ni.com/manuals, for information about additional connection accessories and cabling recommendations.
Complete the following steps to connect the NI 9514 servo 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 37-pin terminal block using the NI 951x Cable and Terminal Block Bundle, or use a custom cable for direct connectivity.

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

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

   **Caution** The 37-pin terminal block has separate $V_{up}$ and COM terminals for each connector. Make sure you are using the correct $V_{up}$ and COM terminals for the connector you are using. All signals associated with the DSUB connector in Figure 3 are marked with a dagger (†).

Figure 1 shows a simplified system connection diagram.
Figure 1. NI 9514 Connection Example
### Table 1. NI 9514 DSUB Connector Pin Assignments

<table>
<thead>
<tr>
<th>Connector</th>
<th>Pin</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>Drive Command COM</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Drive Enable</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Reserved</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Reserved</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Reserved</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Drive Command</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>COM</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Digital Input 1</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Reserved</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Reserved</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Reserved</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>$V_{sup}$</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>Reserved</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>COM</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>Reserved</td>
</tr>
</tbody>
</table>
Figure 2. NI 9514 MDR Connector Pin Assignments
<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>37</td>
<td>GND</td>
</tr>
<tr>
<td>36</td>
<td>Forward Limit</td>
</tr>
<tr>
<td>35</td>
<td>Home</td>
</tr>
<tr>
<td>34</td>
<td>COM</td>
</tr>
<tr>
<td>33</td>
<td>Digital Input 0</td>
</tr>
<tr>
<td>32</td>
<td>COM</td>
</tr>
<tr>
<td>31</td>
<td>Encoder 0 Index+</td>
</tr>
<tr>
<td>30</td>
<td>Encoder 0 Index–</td>
</tr>
<tr>
<td>29</td>
<td>COM</td>
</tr>
<tr>
<td>28</td>
<td>+5V OUT</td>
</tr>
<tr>
<td>27</td>
<td>Position Compare</td>
</tr>
<tr>
<td>26</td>
<td>Reserved</td>
</tr>
<tr>
<td>25</td>
<td>Drive Command†</td>
</tr>
<tr>
<td>24</td>
<td>Reserved</td>
</tr>
<tr>
<td>23</td>
<td>Vsup†</td>
</tr>
<tr>
<td>22</td>
<td>Digital Input 1†</td>
</tr>
<tr>
<td>21</td>
<td>Reserved</td>
</tr>
<tr>
<td>20</td>
<td>COM†</td>
</tr>
<tr>
<td>19</td>
<td>Reserved</td>
</tr>
<tr>
<td>18</td>
<td>Shield</td>
</tr>
</tbody>
</table>

† Indicates DSUB connector signals.
Signal Connections

Figure 4 shows the NI 9514 block diagram.

![NI 9514 Block Diagram](image)

Figure 4. NI 9514 Block Diagram
Note  This document provides a brief overview of the module signal connections. Refer to the *NI 951x User Manual*, which you can download from [ni.com/manuals](http://ni.com/manuals), for more information about signal connections.

The NI 9514 module provides a ±10 V analog Drive Command output. Use the Drive Command COM signal instead of COM as a reference for the Drive Command Output. This reference signal helps keep digital noise separate from the analog output.

The encoder channel consists of a Phase A, a Phase B, and an Index input. The NI 9514 supports RS-422 differential and single-ended inputs for Phase A, Phase B, and Index signals, and provides a +5 V output for encoder power. National Instruments strongly recommends you use encoders with differential line driver outputs for optimized noise immunity and improved accuracy in all applications. Figures 5 and 6 show simplified schematic diagrams of the encoder input circuit connected to differential and single-ended encoder outputs.
Figure 5. Differential Encoder Input Circuit

Figure 6. Single-Ended Encoder Input Circuit
You can configure the Forward Limit, Reverse Limit, and Digital Input <1..2> signals in software for sinking or sourcing output devices and set the active state of the inputs in software to on or off. To use the Drive Fault signal referenced in Figure 1, you can map an available digital input in software. Figure 7 shows an example of wiring the input signals to a sourcing output device.

![Figure 7. Limit or Digital Input Circuit Configured for Sinking](image-url)
Figure 8 shows an example of wiring the input signals to a sinking output device.

The NI 9514 Drive Enable signal is software configurable for sinking or sourcing output type and the active state is software configurable for on or off.
**Caution** Only connect the Drive Enable output to +5 V input circuitry when the output is configured for sinking.

Figure 9 shows an example of wiring the output signals to a sinking input device.

**Figure 9.** Drive Enable Output Circuit Configured for Sourcing
Figure 10 shows an example of wiring the output signals to a sourcing input device.

Figure 10. Drive Enable Output Circuit Configured for Sinking
LED Indicators
The NI 9514 has four LEDs to display status information.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Axis Status (Green)</td>
</tr>
<tr>
<td>2</td>
<td>Encoder Active (Green)</td>
</tr>
<tr>
<td>3</td>
<td>Limit Active (Yellow)</td>
</tr>
<tr>
<td>4</td>
<td>Axis Fault (Red)</td>
</tr>
</tbody>
</table>

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

- **Off**—The required 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 NI 9514 receives encoder pulses.

- **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.

Sleep Mode

This module supports a low-power sleep mode. Support for sleep mode at the system level depends on the chassis that the module is plugged into. Refer to the chassis manual for information about support for sleep mode. If the chassis supports sleep mode, refer to the software help for information about enabling sleep mode. Visit [ni.com/info](http://ni.com/info) and enter cseriesdoc for information about C Series documentation.

Typically, when a system is in sleep mode, you cannot communicate with the modules. In sleep mode, the system consumes minimal power and may dissipate less heat than it does in normal mode. Refer to the *Specifications* section for more information about power consumption and thermal dissipation.
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.

Servo Performance

Module modes of operation .............. Position loop and torque loop
Control loop rate¹.............................. 20 kHz max (position loop)
Servo control loop modes ............... PID, PIVf, and Dual-Loop

Motion Command Signals

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

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.
Drive enable output

- **Output type**: Programmable: sinking or sourcing
- **Voltage range**: 0 to 30 V
- **V<sub>sup</sub> input**: 19 to 30 V
- **Continuous output current (I<sub>0</sub>) on each channel**: ±100 mA max
- **Output impedance (R<sub>0</sub>)**: 0.3 Ω max
- **Output voltage (V<sub>0</sub>) sourcing**: \( V_{sup} - (I_0 R_0) \)
- **Output voltage (V<sub>0</sub>) sinking**: \( I_0 R_0 \)
- **Min output pulse width**: 100 µs
- **Active state**: Programmable: on or off

### Motion I/O

Encoder 0 Phase A/B and Index inputs

- **Type**: RS-422 differential or single-ended inputs
- **Digital logic levels, single-ended**
  - **Voltage**: –0.25 to 5.25 V
  - **High, V<sub>HI</sub>**: 2.0 V min
  - **Low, V<sub>IL</sub>**: 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

Min pulse width\(^2\)
  Differential ..................... 100 ns
  Single-ended .................... 400 ns

Max count rate
  Differential ..................... \(20 \times 10^6\) counts/sec
  Single-ended .................... \(5 \times 10^6\) counts/sec

Forward, reverse, and home inputs
  Input type ........................ Programmable: sinking or sourcing

Digital logic levels, OFF state
  Input voltage .................... ≤ 5 V
  Input current .................... ≤ 250 μA

\(^1\) Common-mode voltage is the average of Phase+ and Phase–.
\(^2\) Assumes the minimum filter setting. Refer to the NI SoftMotion Module book of the LabVIEW Help for more information about filter options.
Digital logic levels, ON state

Input voltage ....................... 11 to 30 V
Input current ....................... ≥ 2 mA
Input impedance ....................... 30 kΩ ± 5%
Min pulse width1 ....................... 100 µs

Position capture input

Digital logic levels

Voltage ................................. –0.25 to 5.25 V
High, V_{HH} ............................ 2.0 V min
Low, V_{IL} .............................. 0.8 V max

Input current

(0 V ≤ V_{in} ≤ 4.5 V) ..................... ±2 mA max
Min pulse width1 ....................... 100 ns
Max capture latency .................... 200 ns
Capture accuracy ....................... ±1 count
Active edge ............................ Programmable: rising edge or falling edge

1 Assumes the minimum filter setting. Refer to the NI SoftMotion Module book of the LabVIEW Help for more information about filter options.
Position compare outputs

High, $V_{OH}$..........................5.25 V max
   Sourcing 12 mA ...............3.7 V min
   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 .......................Programmable: single or periodic

Compare action ........................Programmable: set, toggle, or pulse

Max compare rate (periodic) ......5 MHz

Pulse width (programmable)
   Min....................................100 ns
   Max ..................................1.6 ms

Active state ........................Programmable: high or low
Digital Inputs

Number of inputs ......................... 2
Input type ..................................... Programmable: sinking or sourcing

Digital logic levels, OFF state
  Input voltage .......................... \( \leq 5 \) V
  Input current .......................... \( \leq 250 \) µA

Digital logic levels, ON state
  Input voltage .......................... 11 to 30 V
  Input current .......................... \( \geq 2 \) mA
  Input impedance ......................... 30 kΩ ± 5%

Min pulse width\(^1\) ......................... 50 µs

MTBF .......................................... Contact NI for Bellcore MTBF or MIL-HDBK-217F specifications.

\(^1\) Assumes the minimum filter setting. Refer to the NI SoftMotion Module book of the LabVIEW Help for more information about filter options.
Power Requirements

Power consumption from chassis
- Active mode ....................... 900 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

\( V_{\text{sup}} \) input ......................... 19 to 30 V, 150 mA max
+5 V regulated output ............... 5 V ±5%, 150 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 \( \text{ni.com/dimensions} \) and search by module number.

Weight .............................................. 155 g (5.5 oz)
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 .............................. 60 VDC, Measurement Category I
   Withstand ............................... 500 V<sub>rms</sub>, 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 9514 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 (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

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
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
National Instruments C Series modules are intended for indoor use only, but may be used outdoors if installed in a suitable enclosure. 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

Max altitude ................................... 2,000 m

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

**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 *NI and the Environment* 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 their life cycle, all products must be sent to a WEEE recycling center. For more information about WEEE recycling centers and National Instruments WEEE initiatives, visit ni.com/environment/weee.htm.

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)
Where to Go for Support

The National Instruments Web site is your complete resource for technical support. At ni.com/support you have access to everything from troubleshooting and application development self-help resources to email and phone assistance from NI Application Engineers.

National Instruments corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. National Instruments also has offices located around the world to help address your support needs. For telephone support in the United States, create your service request at ni.com/support and follow the calling instructions or dial 512 795 8248. For telephone support outside the United States, contact your local branch office:

Australia 1800 300 800, Austria 43 662 457990-0, Belgium 32 (0) 2 757 0020, Brazil 55 11 3262 3599, Canada 800 433 3488, China 86 21 5050 9800, Czech Republic 420 224 235 774, Denmark 45 45 76 26 00, Finland 358 (0) 9 725 72511, France 01 57 66 24 24, Germany 49 89 7413130, India 91 80 41190000, Israel 972 3 6393737, Italy 39 02 41309277, Japan 0120-527196,