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cRIO-9014

GETTING STARTED

NI 9501 C Series Stepper Drive Modules and NI SoftMotion Module



Note If you are a new user of LabVIEW or are unfamiliar with LabVIEW, refer to the *Getting Started with LabVIEW* manual for information about LabVIEW and LabVIEW terminology.

This document explains how to use an NI 9501 C Series drive module with LabVIEW NI SoftMotion Module User-Defined Variable (UDV) axes, using an NI 9501 C Series drive module example to demonstrate concepts and programming best practices.



Tip If you encounter any problems during setup, refer to the *Tips and Troubleshooting* section for assistance.

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What You Need to Get Started

You need the following items to get started.

Hardware

- NI 9501 C Series stepper drive module
- NI CompactRIO real-time controller and chassis
- 24 V power supply (such as the NI PS-15) for the CompactRIO controller (NI part number 781093-01)
- 24 V power supply (such as the NI PS-16) for the NI 9501 module and NI 9411 module (if connecting an encoder) (NI part number 781094-01)



Note NI recommends the NI PS-16 power supply, which is designed for motor bus power, for use with the NI 9501 module. Refer to *Regeneration Consideration Using the NI C Series Drive Modules* at zone.ni.com for more information.

- Ethernet connection and cable for the CompactRIO controller
- NI or third-party stepper motor



Note NI offers NEMA 17 and NEMA 23 stepper motors compatible with the NI 9501. Go to ni.com for more information.

Optional Hardware

- NI or third-party encoder



Note NI offers encoders for NEMA 23 stepper motors. Go to ni.com for more information.

- NI 9411 digital input module for encoder connections (NI part number 779005-01)
- NI 9935 15-pin D-SUB connector kit for connecting the NI 9411 (NI part number 779016-01)
- NI 9401 high-speed bidirectional digital I/O module for position compare and position capture operations (NI part number 779351-01)
- NI 9924 25-pin D-SUB connector kit for connecting the NI 9401 (NI part number 781922-01)

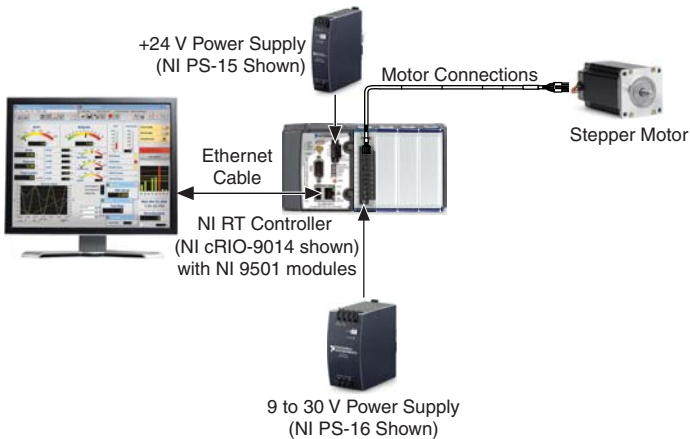
- NI 9423 sinking digital input module for home, limit, and digital input connections (NI part number 779009-01)
- NI 9472 sourcing digital output module for digital output connections (NI part number 779004-01)

Software

- LabVIEW 2012 SP1 or later
- LabVIEW 2012 SP1 Real-Time Module or later
- LabVIEW 2012 SP1 FPGA Module or later
- LabVIEW 2012 SP1 NI SoftMotion Module or later
- NI-RIO Device Drivers 2012 or later

Figure 1 shows the system setup without optional hardware. The [Setting Up and Using Optional Hardware](#) section discusses optional hardware, including a connection diagram and example walkthrough of optional functionality.

Figure 1. NI SoftMotion Module with NI 9501 UDV Axis System Overview

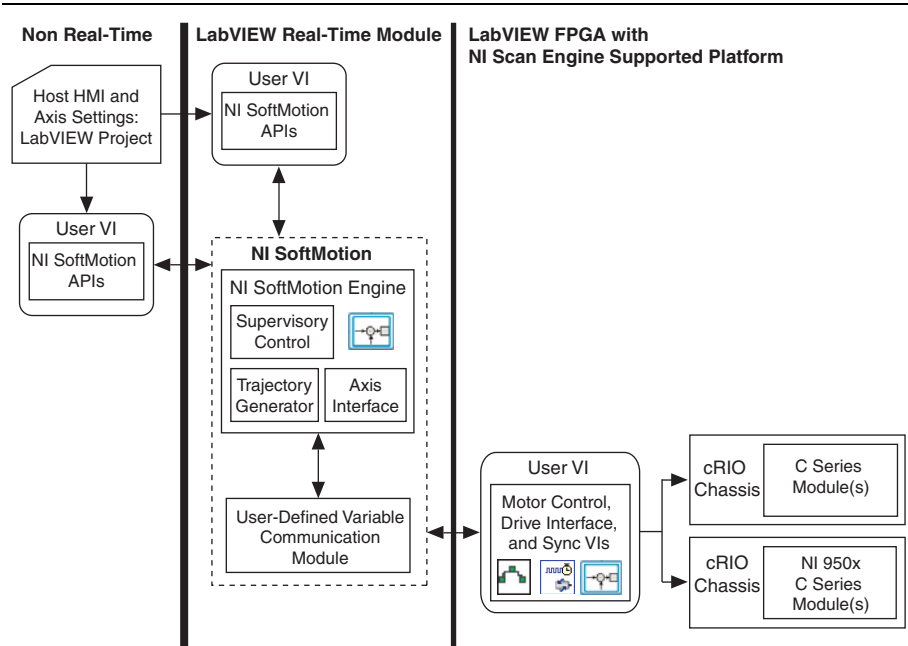


NI SoftMotion Module Overview

NI SoftMotion Module UDV axes allow you to implement an interface for communication between the NI SoftMotion Engine and the LabVIEW FPGA Module. This is achieved using user-defined variables that you add to the project, making it easier to use C Series modules in FPGA mode with the NI SoftMotion Module.

The following figure shows the NI SoftMotion architecture when you use the NI SoftMotion Module with UDV axes and the LabVIEW FPGA Module.

Figure 2. NI SoftMotion Module with UDV Axes



You use the LabVIEW Project to configure your axis settings and test your configuration. When your hardware configuration is complete, you use NI SoftMotion APIs to create move profiles.

Communication to the LabVIEW FPGA Module is handled through user-defined variables. You use the NI SoftMotion Drive Interface VIs to implement an interface for communication between the NI SoftMotion Engine and the LabVIEW FPGA Module. When you use the Drive Interface VIs with UDV axes you communicate using a predefined set of UDVs. Refer to *Adding User-Defined Variables for Use With a UDV Axis* in the *NI SoftMotion Module Help*, available by selecting **Help>LabVIEW Help** for information about the predefined UDVs. Refer to the [Using NI 9501 with NI SoftMotion](#) section for more information about the NI SoftMotion Drive Interface VIs.

Hardware and Software Installation

This section covers the hardware and software setup for the CompactRIO system and NI 9501 C Series drive module. Refer to the [Setting Up and Using Optional Hardware](#) section for information about connecting additional hardware.

Step 1: Set Up the CompactRIO System

Complete the following steps to set up the CompactRIO hardware.

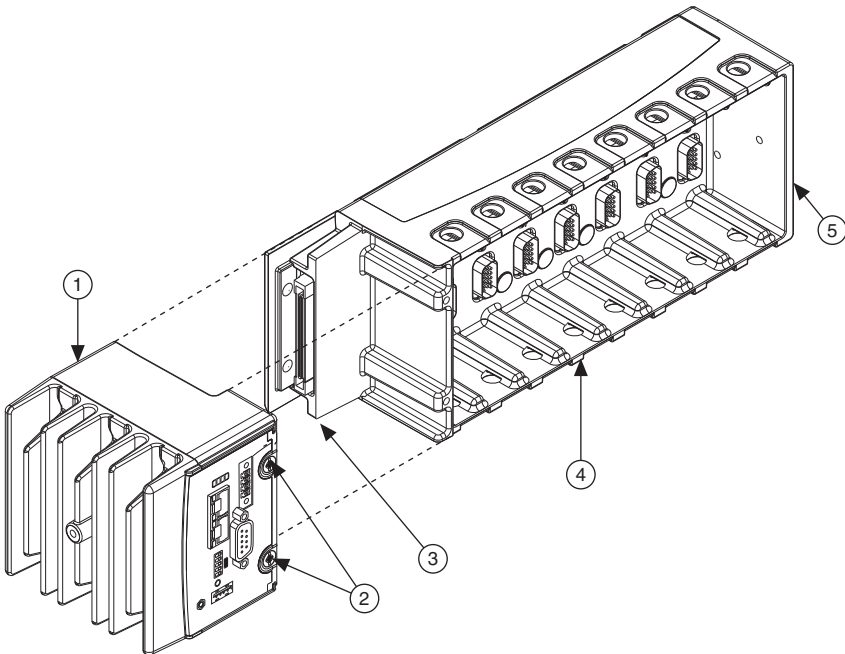
1. Install the real-time CompactRIO controller on the chassis if you are not using an integrated controller and chassis.



Note Write down the controller serial number before installing the controller onto the chassis. You will be unable to read the serial number after you install the controller.

- a. Make sure that no power is connected to the controller or the chassis.
- b. Align the controller with the chassis as shown in Figure 3.

Figure 3. Installing the Controller on the Chassis (Eight-Slot Chassis Shown)



- | | |
|-------------------|-----------------------------------|
| 1 Controller | 4 Reconfigurable Embedded Chassis |
| 2 Captive Screws | 5 Grounding Screw |
| 3 Controller Slot | |

- c. Slide the controller onto the controller slot on the chassis. Press firmly to ensure the chassis connector and the controller connector are mated.
 - d. Using a number 2 Phillips screwdriver, tighten the two captive screws on the front of the controller.
2. Connect the controller to a power supply and an Ethernet network on the same subnet as the development computer. Refer to the controller operating instructions for information about wiring the controller to the power supply and Ethernet network.



Note Do not plug in or turn on any power to the system until after all hardware connections are complete.

3. Install the NI 9501 module in slot 1 of the chassis, if available.

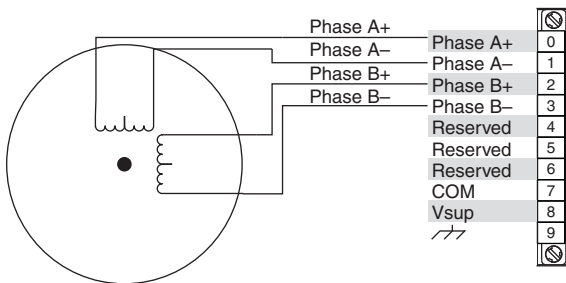


Note The NI 9501 example programs are configured for slot 1. If the NI 9501 module is installed in a different slot, modify the examples accordingly.

Step 2: Connect NI 9501 to the Stepper Motor

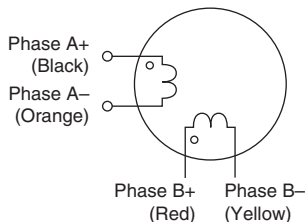
1. Connect the stepper motor to the NI 9501. Figure 4 shows a typical bipolar stepper motor connection. Refer to the *NI 9501 Operating Instructions and Specifications* for important connection information, including information about EMC compliance and connecting 6- or 8-wire stepper motors.

Figure 4. NI 9501 Bipolar Stepper Motor (2-Phase Type) Connection



NEMA 17 and NEMA 23 stepper motors from NI use the following wire color scheme.

Figure 5. Stepper Motor Wiring



Step 3: Connect the NI 9501 to the NI PS-16 Power Supply



Tip Refer to the *NI PS-16 Power Supply User Manual and Specifications* for more information about connecting and using the NI PS-16 power supply.

Complete the following steps to connect the NI 9501 module to the NI PS-16 power supply.



Tip Refer to the *NI 9501 Operating Instructions and Specifications* for more information about module power supply requirements.

1. Connect the NI 9501 Vsup (pin 8) to one of the two (+) terminals on the NI PS-16.
2. Connect the NI 9501 COM (pin 7) to one of the two (-) terminals on the NI PS-16.
3. Connect the power supply to AC power.

Step 4: Connect the System to AC Power

Complete the following steps to power on the system.

1. Connect the controller power supply to AC power.
2. Connect the NI 9501 power supply to AC power.


Step 5: Install Software on and Configure the NI RT Controller

This step covers installing and configuring the software for the NI 9501 stepper drive module. It assumes that all required software from the [What You Need to Get Started](#) section is installed on the host machine.

Complete the following steps to configure the controller and install software on it.



Note The Measurement & Automation Explorer (MAX) user interface may not match these steps exactly depending on which version of MAX you are using.

1. Launch Measurement & Automation Explorer (MAX) on the development computer by double-clicking the MAX icon on the desktop () or by selecting **Start»All Programs»National Instruments»Measurement & Automation**.
2. Expand the **Remote Systems** tree.
3. Highlight your device.



Note If you do not see the controller, you may need to disable the firewall on the development computer. Go to ni.com/info and enter RIOMAXTroubleshoot for more information.

4. Verify that the **Serial Number** in the **General Settings** section matches the serial number on the device.
5. If you do not want to format the disk on the controller, eliminating all installed software and files, skip to step 15.
6. Set the **Safe Mode** switch on the controller to the **On** position.



Note If your controller supports the **Attempt to restart into safe mode** option, you can programmatically enable safe mode rather than using the hardware switch and skip to step 8.

7. Power on the controller. If it is already powered on, press the **Reset** button on the controller to reboot it.
8. Right-click the controller under **Remote Systems** in the configuration tree in MAX and select **Format Disk**.
9. (Optional) Enable either the **Preserve the primary adapter settings and disable the others** or **Preserve the settings for all network adapters** options if you want to retain the same target name and IP address and retain settings for the secondary network adapter, if available.
10. Click **Format** to start formatting the disk.
11. When MAX finishes formatting the disk, set the **Safe Mode** switch to the **Off** position (if necessary) and click **OK** in the confirmation dialog box.
12. Select the **System Settings** tab on the bottom and type a descriptive name for the system in the **Hostname** field.
13. (Optional) Complete this step only if the target has an empty IP address (0.0.0.0). Select the **Network Settings** tab and select **DHCP or Link Local** from the **Configure IPv4 Address** list to assign an IP address or select the **Static** to specify a static IP address in the **IPv4 Address** section.
14. Click **Save** on the toolbar and let MAX reboot the system. You may not need to complete this step if you did not change the IP address or name.
15. When the new system name appears under **Remote Systems**, expand the controller item in the tree, right-click **Software**, and select **Add/Remove Software**.
16. Select a recommended software set that includes NI-RIO 2012 or later. Click **Help** if you need information about installing recommended software sets.
17. Click **Next**.
18. Select **LabVIEW NI SoftMotion Module** from the add-ons list.
19. Click **Next** to install the selected software on the controller.
20. When the software installation completes, click **Finish** to reboot the controller.
21. Make a note of the IP address assigned to the controller, to use when adding the target in LabVIEW.
22. Close MAX.

Using NI 9501 with NI SoftMotion

The following tutorial walks you through using an NI 9501 UDV axis using the Stepper Drive (Getting Started) example installed in the <labview>\examples\motion\UDV\Stepper Drive (Getting Started) directory. This example shows how to configure the NI 9501 for a UDV axis using the LabVIEW project and contains all required UDV's for use with the NI 9501.



Note NI SoftMotion FPGA examples are configured with a cRIO-9074 chassis. Go to ni.com/info and enter `fpgaex` for information about how to move the example to a different FPGA target.

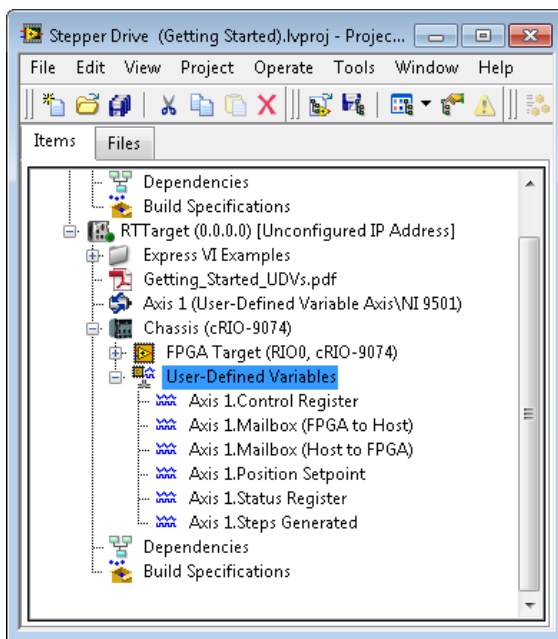
1. Open `Stepper Drive (Getting Started).lvproj`.
2. Right-click the **RTTarget** item in the **Project Explorer** window and select **Properties** from the shortcut menu to open the real-time target properties dialog box.
3. On the **General** page, enter the IP address you configured in [Step 4: Connect the System to AC Power](#).
4. Click **OK**.
5. Right-click the target and select **Connect** from the shortcut menu. The RT target icon in the **Project Explorer** window changes to indicate a front panel connection with the RT target.

NI SoftMotion UDV Axes and Configuration Data

This section describes each UDV used in the example and explains how module configuration data is communicated from the LabVIEW Project to the LabVIEW FPGA Module.

1. Expand the **RTTarget** item in the **Project Explorer** window.
2. Expand the **Chassis** item, then expand the **User-Defined Variables** item to display the UDV's used in the example. Figure 6 shows the LabVIEW Project with the UDV's displayed.

Figure 6. Stepper Drive (Getting Started) User-Defined Variables



The following table briefly describes each UDV used in the project. Refer to *Adding User-Defined Variables for Use With a UDV Axis* in the *NI SoftMotion Module Help* for more information about each UDV.

Table 1. Stepper Drive (Getting Started) UDV Descriptions

| UDV Name | Description |
|-------------------------------|--|
| Axis 1.Control Register | Contains information used to control the state and operating mode of the device. |
| Axis 1.Mailbox (FPGA to Host) | Contains information used to provide configuration and other data from FPGA to the NI SoftMotion Engine. |
| Axis 1.Mailbox (Host to FPGA) | Contains information used to provide configuration and other data from the NI SoftMotion Engine to FPGA. |
| Axis 1.Position Setpoint | Specifies the position setpoint. |

Table 1. Stepper Drive (Getting Started) UDV Descriptions (Continued)

| UDV Name | Description |
|------------------------|---|
| Axis 1.Status Register | Contains information used to report status and operation mode information from the device to the system. |
| Axis 1.Steps Generated | Returns the current step count of the stepper generator taking into account the direction. This value is based on actual steps generated, not feedback position, and may not exactly match the feedback position. |

NI SoftMotion Engine to FPGA Communication

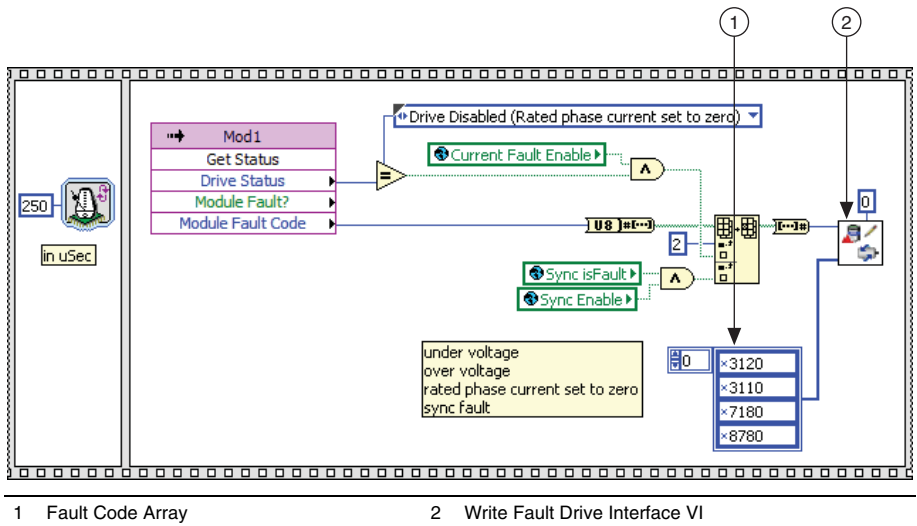
Each User-Defined Variable communicates information between the NI SoftMotion Engine and the LabVIEW FPGA Module. These UDVs are used directly with the Drive Interface FPGA VIs in specific loops on the block diagram. Complete the following steps to open the FPGA VI and display the block diagram.

1. Expand the **FPGA Target** item in the LabVIEW Project Explorer window.
2. Double-click the **Stepper Drive (Getting Started) - FPGA.vi** item to open the VI.
3. Select **Window»Show Block Diagram** to open the FPGA VI block diagram.

Fault Monitoring Loop

The Fault Monitoring loop sends fault information, including user-defined faults, to the NI SoftMotion engine and sends the state machine implemented in the Control Status Loop into a fault state. Figure 7 shows the Fault Monitoring Loop from the Stepper Drive (Getting Started) example.

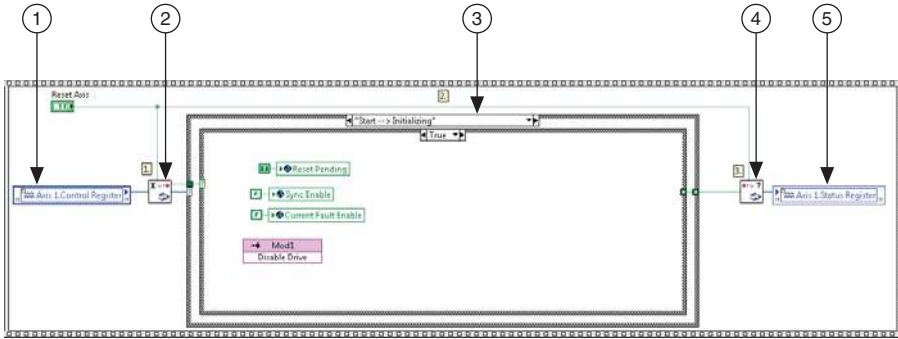
Figure 7. Stepper Drive (Getting Started) Fault Monitoring Loop



Control Status Loop

The Axis 1.Control Register and Axis 1.Status Register UDV's are used in the Control Status Loop. Figure 8 shows the Control Status Loop from the Stepper Drive (Getting Started) example.

Figure 8. Stepper Drive (Getting Started) Control Status Loop



- | | | | |
|---|---|---|---|
| 1 | Axis 1.Control Register UDV | 4 | Generate Status Register Drive Interface VI |
| 2 | Interpret Control Register Drive Interface VI | 5 | Axis 1.Status Register UDV |
| 3 | State Change Case Structure | | |

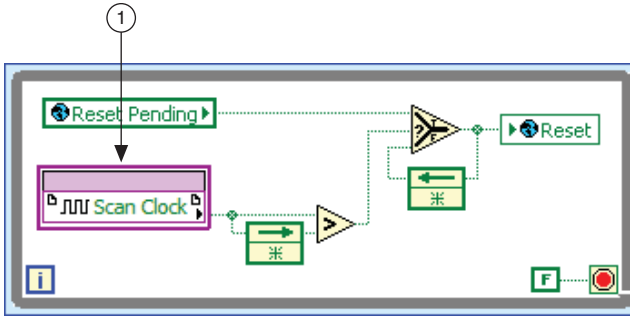
The Control Status Loop interprets the Control Register UDV and recognizes state changes, executes the appropriate action on a state change, and generates the Status Register UDV that returns information to the NI SoftMotion Engine.

Review the operations that occur at each transition inside the State Change Case structure. The *Interpret Control Register* and *Generate Status Register* topics in the *NI SoftMotion Help* describe the valid state transitions and which operations should occur in each state.

Reset Monitoring Loop

The Reset Monitoring Loop latches the reset variable so that it only changes on a rising edge of the Scan Clock. This allows proper operation of the NI SoftMotion Motor Control VIs with a **reset** input. Figure 9 shows the Stepper Drive (Getting Started) Reset Monitoring Loop.

Figure 9. Stepper Drive (Getting Started) Reset Monitoring Loop

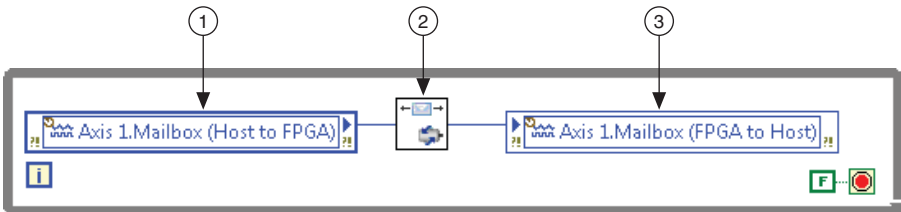


1 Scan Clock

Mailbox Loop

The Axis 1.Mailbox (FPGA to Host) and Axis 1.Mailbox (Host to FPGA) UDVs are used in the Mailbox Loop. Figure 10 shows the Mailbox Loop from the Stepper Drive (Getting Started) example.

Figure 10. Stepper Drive (Getting Started) Mailbox Loop



1 Axis 1.Mailbox (Host to FPGA) UDV
2 Mailbox Handler Drive Interface VI

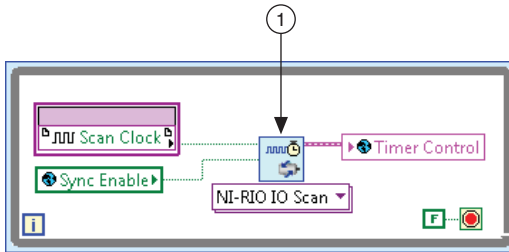
3 Axis 1.Mailbox (FPGA to Host) UDV

The Mailbox Loop transfers axis configuration and other data between the NI SoftMotion Engine and the LabVIEW FPGA Module. The transferred data is written to FPGA memory and accessed using the Read Motion Memory and Write Motion Memory Drive Interface VIs. This loop is required to be implemented as-is for proper operation.

Synchronization Loop

The Synchronization Loop synchronizes the FPGA clock (slave) to the RT clock (master) to correct for drift and jitter. This is the preferred synchronization method to use with the NI SoftMotion Module. Figure 11 shows the Synchronization Loop from the Stepper Drive (Getting Started) example.

Figure 11. Stepper Drive (Getting Started) Synchronization Loop



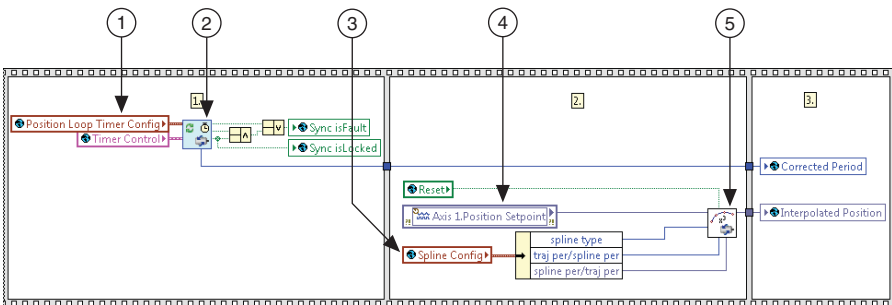
- 1 NI SoftMotion Scan - Generate Sync Scan Synchronization VI

The Synchronization Loop is required to be implemented as-is for proper operation. Refer to the *Synchronization VIs* section of the *NI SoftMotion Module Help* for more information.

Position Loop and Step Generation Loop

The Axis 1.Position Setpoint UDV is used in the Position Loop. Figure 12 shows the Position Loop from the Stepper Drive (Getting Started) example.

Figure 12. Stepper Drive (Getting Started) Position Loop

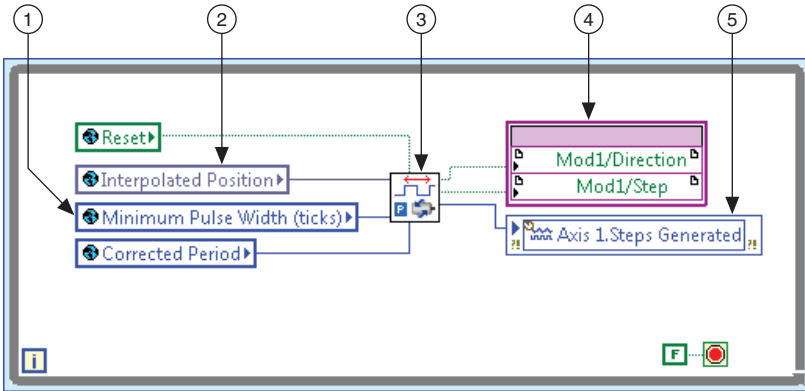


- 1 Synchronization Inputs
- 2 NI SoftMotion Scan - Loop Timer VI
- 3 Spline Configuration Information from NI SoftMotion
- 4 Axis 1.Position Setpoint UDV
- 5 Spline Interpolation Motor Control VI

The Position Loop receives position setpoints from the NI SoftMotion trajectory generator and uses the Spline Interpolation VI to generate intermediate setpoints, resulting in smoother motion. The Position Loop receives input from the Synchronization Loop as well as timing information calculated by the NI SoftMotion Engine. This timing information is provided to divide down the Scan Clock evenly to run the position loop at the user-specified stepper **Position Loop Period**.

The Position Loop sends interpolated position points to the Step Generation Loop, shown in Figure 13.

Figure 13. Stepper Drive (Getting Started) Step Generation Loop



- | | | | |
|---|--|---|------------------------------------|
| 1 | Minimum Pulse Width from NI SoftMotion Configuration | 4 | NI 9501 Step and Direction Signals |
| 2 | Interpolated Position from Position Loop | 5 | Axis 1.Steps Generated UDV |
| 3 | Position Step Frequency Modulation Motor Control VI | | |

The Step Generation Loop uses the Position Step Frequency Modulation Motor Control VI to convert the interpolated position points to Step and Direction signals and returns the steps generated so that this information can be sent to the NI SoftMotion Engine.

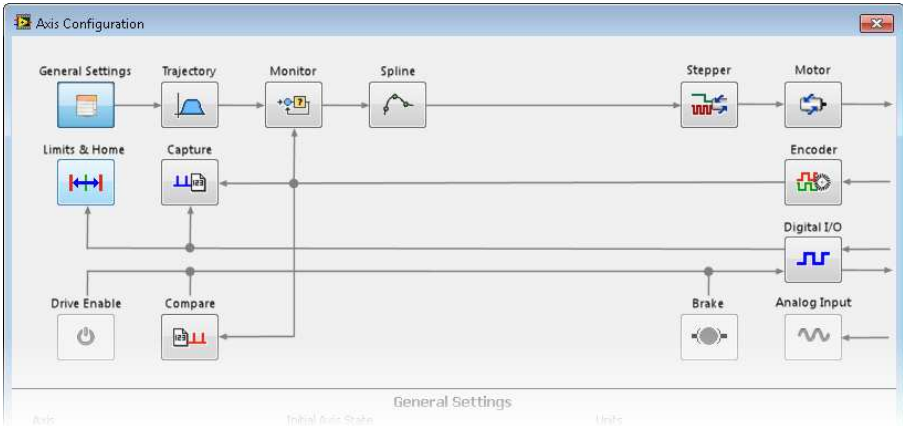
Compile and Run the Example

Complete the following steps to compile and run the example.

1. Right-click the axis in the Project Explorer window and select **Properties** from the shortcut menu to open the **Axis Configuration** dialog box. The **Axis Configuration** dialog box includes configuration options for stepper drive command signals, feedback devices, motion and digital I/O, trajectory, and axis setup.

Figure 14 shows the parts of the **Axis Configuration** dialog box for NI 9501 UDV axes. Refer to the *NI SoftMotion Module* section of the *LabVIEW Help* for detailed information about each configuration option.

Figure 14. Axis Configuration Dialog Box for NI 9501 UDV Axes



Note The **Axis Configuration** dialog box user interface may not match this image exactly depending on which version of the LabVIEW NI SoftMotion Module you are using.


- Click the **Motor** button () and set the **Rated Phase Current** to the appropriate value for your motor in Amps/Phase. Use the motor datasheet and the type of motor connection used to determine this setting based on the following table.

Table 2. NI 9501 Rated Phase Current Setting



| Connection Type | Rated Phase Current (Amps/Phase) |
|------------------|-------------------------------------|
| Bipolar 4-wire | same as datasheet Amps/Phase |
| 6-wire series | datasheet Amps/Phase \times 0.707 |
| 6-wire half-coil | same as datasheet Amps/Phase |
| 8-wire series | datasheet Amps/Phase \times 0.707 |
| 8-wire parallel | datasheet Amps/Phase \times 1.414 |
| 8-wire half coil | same as datasheet Amps/Phase |

- Click **OK** to close the **Axis Configuration** dialog box.
- Right-click the **Chassis** item in the **Project Explorer** window and select **Deploy** from the shortcut menu.


5. Click the Run button on the Stepper Drive (Getting Started) - FPGA.vi. Clicking the **Run** button compiles the VI only if the VI or project has changed since you last compiled the VI.







Note The compilation process goes through several stages. Compiling FPGA VIs can take from a few minutes to a few hours. National Instruments recommends testing and debugging an FPGA VI before you compile it. Refer to *Introduction to Debugging FPGA VIs on an FPGA Target* in the *FPGA Module Help* for more information.

6. Verify that the FPGA VI is running. When a VI runs, the Run button () changes to a darkened arrow () to indicate that the VI is running. If the VI is not running, press the Run button.
7. Right-click the axis in the **Project Explorer** window and select **Interactive Test Panel** from the shortcut menu.



Tip Click the **Help** button () on the bottom of the dialog box for detailed information about the items available in this dialog box.

8. Click the **Enable** button () on the bottom of the dialog box to enable the drive.
9. Click the **Start** button () on the bottom of the dialog box to start the move with the configured options. If you encounter any errors or faults, refer to the [Tips and Troubleshooting](#) section for possible solutions.
10. Use the **Status** and **Plots** tabs to monitor the move while it is in progress.
11. Click the **Stop** button () to stop a move in progress.
12. Click the **Disable** button () on the bottom of the dialog box to disable the drive when you are finished testing it.

Setting Up and Using Optional Hardware

This section describes how to configure and use the NI 9501 with additional hardware to provide encoder feedback, limit and home inputs, digital I/O, and compare and capture operations. The Stepper Drive (with Encoder) example contains four additional modules and additional UDVs and FPGA loops to support these operations. Figure 15 shows the system setup with the additional hardware.

Figure 15. NI SoftMotion Module with NI 9501 UDV Axis System Overview

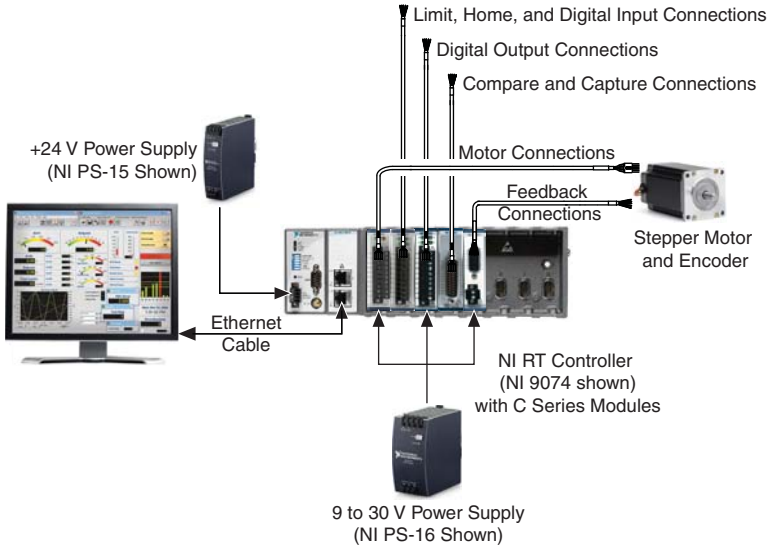


Table 3 shows the additional modules and what they are used for in the Stepper Drive (with Encoder) example.

Table 3. Additional C Series Modules Used in the Stepper Drive (with Encoder) Example

| C Series Module | Slot Number | Purpose |
|---|-------------|---------------------------------------|
| NI 9423 Sinking Digital Input Module | 2 | Limits, Home, and Digital Inputs |
| NI 9472 Sourcing Digital Output Module | 3 | Digital Outputs |
| NI 9401 High-Speed Bidirectional Module | 4 | Position Compare and Position Capture |
| NI 9411 Digital Input Module | 5 | Encoder Inputs |

Adding and Connecting Additional Modules

Add and Connect an NI 9423 Digital Input Module

1. Install and connect an NI 9423 digital input module in slot 2 of the chassis.
2. Connect the forward, reverse, and home switch to the NI 9423 as follows:

Table 4. NI 9411 Limit and Home Connections

| NI 9423 Signal | Function |
|----------------|---------------|
| DI5 | Reverse Limit |
| DI6 | Forward Limit |
| DI7 | Home Switch |

3. Connect additional digital inputs to the following channels.

Table 5. NI 9411 Digital Input Connections

| NI 9423 Signal | Function |
|----------------|-----------------|
| DI0 | Digital Input 0 |
| DI1 | Digital Input 1 |
| DI2 | Digital Input 2 |
| DI3 | Digital Input 3 |
| DI4 | Digital Input 4 |

Add and Connect an NI 9472 Digital Output Module

1. Install and connect an NI 9472 digital output module in slot 3 of the chassis.
2. Connect digital output devices to the NI 9472.
3. Connect the NI 9472 to the NI PS-16 power supply.
 - a. Connect an available NI 9472 Vsup terminal to one of the two (+) terminals on the NI PS-16.
 - b. Connect an available NI 9472 COM terminal to one of the two (-) terminals on the NI PS-16

Add and Connect an NI 9401 High-Speed Bidirectional Module

1. Install and connect an NI 9401 digital I/O module in slot 4 of the chassis.
2. Connect the position compare and position capture signals as follows:

Table 6. NI 9401 Position Capture and Position Compare Connections

| NI 9401 Signal | Function |
|----------------|-------------------------|
| DIO0 | Position Capture Input |
| DIO4 | Position Compare Output |

Add and Connect an NI 9411 Digital Input Module

1. Install an NI 9411 digital input module in slot 5 of the chassis.
2. Connect the encoder to the NI 9411. The NI 9411 also provides a +5 V supply for encoder power. The Stepper Drive (with Encoder) example uses the following NI 9411 signals for the corresponding encoder signals.

Table 7. NI 9411 Encoder Connections


| NI 9411 Signal | Encoder Signal |
|----------------|-----------------|
| DIO | Encoder Phase A |
| DI1 | Encoder Phase B |
| DI2 | Encoder Index |

3. Connect the NI 9411 to the NI PS-16 power supply.
 - a. Connect the NI 9411 Vsup terminal to one of the two (+) terminals on the NI PS-16.
 - b. Connect the NI 9411 COM terminal to one of the two (-) terminals on the NI PS-16.

Additional UDVs and FPGA VI Loops

The Stepper Drive (with Encoder) example contains several additional UDVs and loops to implement the new functionality. In addition to the UDVs described in Table 1, the Stepper Drive (with Encoder) example uses the following new UDVs. Refer to *Adding User-Defined Variables for Use With a UDV Axis* in the *NI SoftMotion Module Help* for more information about each UDV.

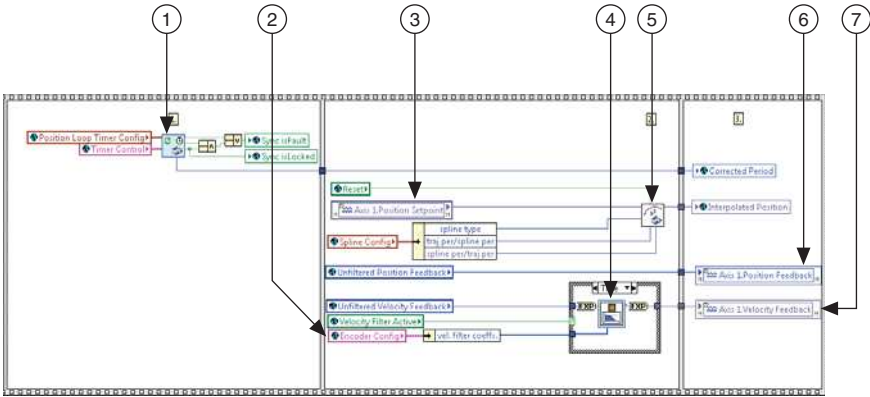
Table 8. Stepper Drive (with Encoder) Additional UDV Descriptions

| UDV Name | Description |
|-----------------------------|---|
| Axis 1.DIO Control (Port A) | Contains the values of digital outputs 0 through 3 as well as information to clear input latches for limits, home, and digital inputs 0 through 3. |
| Axis 1.DIO Control (Port B) | Contains the values of digital outputs 4 through 7 as well as information to enable position compare and position capture operations and clear input latches for digital inputs 4 through 7.  Note Because the same digital input module is used for digital inputs and for home and limit connections, the Stepper Drive (with Encoder) example only uses digital inputs 0 through 4. Digital inputs 5 through 7 are not used in the example. |
| Axis 1.DIO Status (Port A) | Contains information used to report value and latching information for limits, home, and digital inputs 0 through 3. |
| Axis 1.DIO Status (Port B) | Contains information used to report value and latching information for position capture, position compare, and digital inputs 4 through 7. |
| Axis 1.Position Feedback | Specifies the feedback position from the encoder. |
| Axis 1.Velocity Feedback | Returns the filtered encoder velocity. |

Position Loop

Figure 16 shows the Position Loop from the Stepper Drive (with Encoder) example.

Figure 16. Stepper Drive (with Encoder) Position Loop



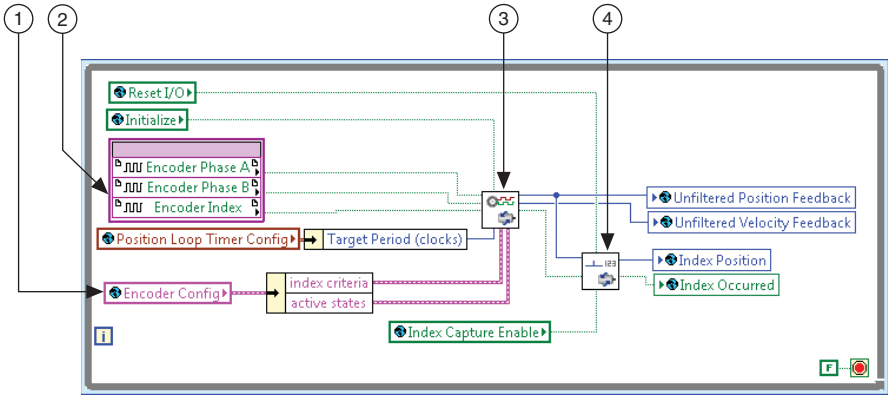
- | | |
|--|---|
| 1 NI SoftMotion Scan - Loop Timer VI | 5 Spline Interpolation Motor Control VI |
| 2 Encoder Configuration Information from NI SoftMotion | 6 Axis 1.Position Feedback UDV |
| 3 Axis 1.Position Setpoint UDV | 7 Axis 1.Velocity Feedback UDV |
| 4 FPGA Butterworth Filter VI | |

When used with encoder feedback, the Position Loop calculates interpolated positions, filters the encoder velocity using the user-specified filter settings, and returns the feedback position and filtered velocity feedback information to the NI SoftMotion Engine.

Encoder Loop

Figure 17 shows the Encoder Loop from the Stepper Drive (with Encoder) example.

Figure 17. Stepper Drive (with Encoder) Encoder Loop



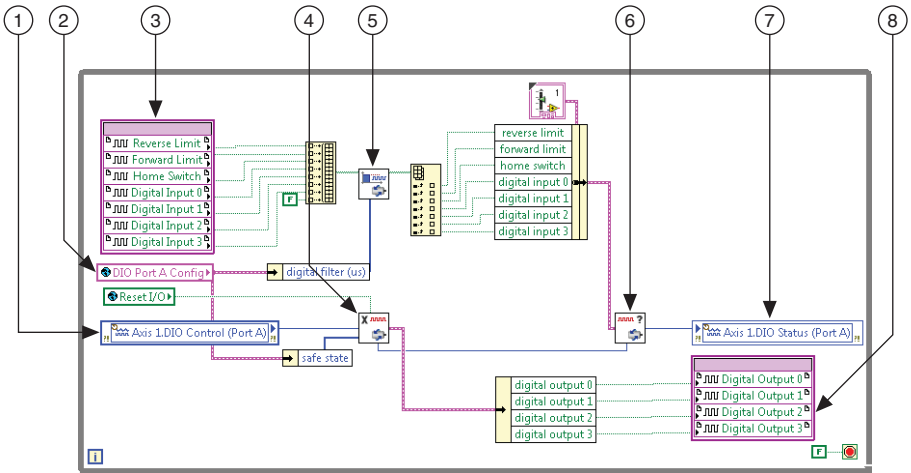
- | | |
|--|---|
| 1 Encoder Configuration Information from NI SoftMotion | 3 Incremental Encoder Decoder Motion Control VI |
| 2 Encoder Input Signals | 4 Position Capture Motor Control VI |

The encoder loop uses the signals from the NI 9411 module to generate position and velocity feedback. Position Capture operations are included in the encoder loop to perform the Index capture operation for use with the NI SoftMotion Find Index routine.

DIO Config Port A Loop

Figure 18 shows the DIO Config Port A loop from the Stepper Drive (with Encoder) example.

Figure 18. Stepper Drive (with Encoder) DIO Config Port A Loop



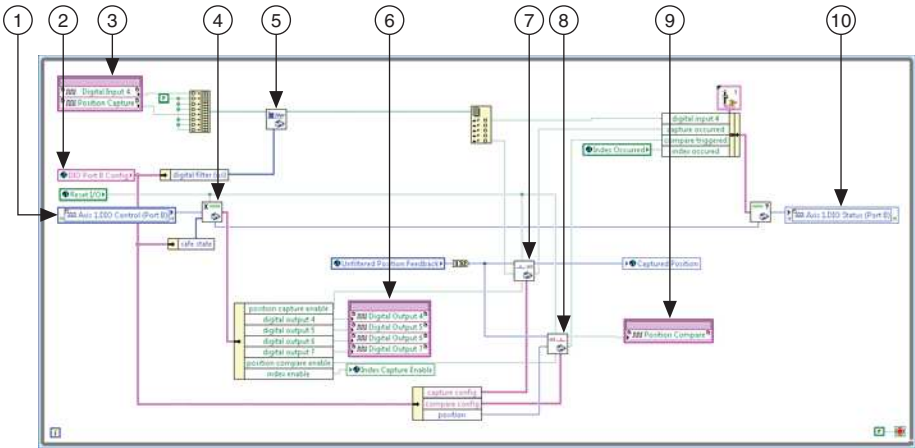
- | | | | |
|---|---|---|---|
| 1 | Axis 1.DIO Control (Port A) | 5 | Digital Filter Motor Control VI |
| 2 | DIO Port A Configuration Information from NI SoftMotion | 6 | Generate DIO Status (Port A) Drive Interface VI |
| 3 | Limit, Home, and Digital Input 0 through 3 Signals | 7 | Axis 1.DIO Status (Port A) |
| 4 | Interpret DIO Control (Port A) Drive Interface VI | 8 | Digital Output 0 through 3 Signals |

The DIO Config Port A loop manages the DIO contained in DIO Port A. This includes the Forward Limit, Reverse Limit, Home Switch, and Digital Inputs 0 though 3 from the NI 9423 C Series module, and Digital Outputs 0 through 3 that are sent to the NI 9472 C Series module.

DIO Config Port B Loop

Figure 18 shows the DIO Config Port B loop from the Stepper Drive (with Encoder) example.

Figure 19. Stepper Drive (with Encoder) DIO Config Port B Loop



- | | |
|---|--|
| <ul style="list-style-type: none"> 1 Axis 1.DIO Control (Port B) 2 DIO Port B Configuration Information from NI SoftMotion 3 Digital Input 4 through 7 and Position Capture Input Signals 4 Interpret DIO Control (Port B) Drive Interface VI | <ul style="list-style-type: none"> 5 Digital Filter Motor Control VI 6 Digital Output 4 through 7 Signals 7 Position Capture Motor Control VI 8 Position Compare Motor Control VI 9 Position Compare Output Signals 10 Generate DIO Status (Port B) Drive Interface VI |
|---|--|

The DIO Config Port B loop manages the DIO contained in DIO Port B. This includes the Position Capture Input and Position Compare Output from the NI 9401 C Series module, Digital Inputs 4 through 7 from the NI 9423 C Series module, and Digital Outputs 4 through 7 that are sent to the NI 9472 C Series module.

Tips and Troubleshooting

Drive Fault on Enable

If you receive fault 7180 when you enable the NI 9501, verify that the **Rated Phase Current** setting is set to the appropriate value for your motor in Amps/Phase. Refer to Table 2 for information about how to determine this value.

Complete the following steps to correct the setting:

1. Set the **Rated Phase Current** in the **Axis Configuration** dialog box and click **OK** when you are done.
2. Right-click the axis in the **Project Explorer** window and select **Deploy** from the shortcut menu to deploy the updated setting.

Where to Go Next

The following documents contain additional information that you may find helpful. All referenced documents ship with the product and are available at ni.com/manuals.

- Operating instructions for the controller
- *NI 9501 Operating Instructions and Specifications*—Use this document to learn how to use the National Instruments 9501, including specifications and pin assignments for the NI 9501.
- *NI 9411 Operating Instructions and Specifications*—Use this document to learn how to use the National Instruments 9411, including specifications and pin assignments for the NI 9411.
- *LabVIEW NI SoftMotion Module Help*—Use this help file to learn about using the NI SoftMotion Module in LabVIEW including information about function blocks and using the NI SoftMotion Module with the LabVIEW Project. To access this help file from LabVIEW, select **Help»LabVIEW Help**, then expand the *LabVIEW NI SoftMotion Module* book on the **Contents** tab.
- *LabVIEW Help*—Use the *LabVIEW Help* to access information about LabVIEW programming concepts, step-by-step instructions for using LabVIEW, and reference information about LabVIEW VIs, functions, palettes, menus, tools, properties, methods, events, dialog boxes, and so on. The *LabVIEW Help* also lists the LabVIEW documentation resources available from National Instruments. Access the *LabVIEW Help* by selecting **Help»LabVIEW Help**.
- *Getting Started with LabVIEW*—Use this document as a tutorial to familiarize yourself with the LabVIEW graphical programming environment and the basic LabVIEW features you use to build data acquisition and instrument control applications. Access the *Getting Started with LabVIEW* PDF by selecting **Start»All Programs»National Instruments»LabVIEW»LabVIEW Manuals»LV_Getting_Started.pdf**.
- *NI PS-16 Power Supply User Manual and Specifications*—Use this document to learn about the features and specifications of the NI PS-16 power supply and information about installing the power supply.

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