Getting Started with NI 951x C Series Modules and LabVIEW™

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

This tutorial demonstrates how to develop a motion application using the NI 951x C Series modules in LabVIEW using the RIO Scan Interface and the LabVIEW NI SoftMotion Module. The application uses a CompactRIO Reconfigurable Embedded system with LabVIEW and the LabVIEW NI SoftMotion Module to perform a series of two-axis moves. While developing this application, you will learn the concepts and techniques necessary to develop deterministic motion applications using NI SoftMotion function blocks and the RIO Scan Interface. The RIO Scan Interface enables you to use C Series modules directly from LabVIEW Real-Time.

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Conventions

The following conventions appear in this manual:

»	The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **Options»Settings»General** directs you to pull down the **Options** menu, select the **Settings** item, and select **General** from the last dialog box.
	This icon denotes a tip, which alerts you to advisory information.
	This icon denotes a note, which alerts you to important information.
	This icon denotes a caution, which advises you of precautions to take to avoid injury, data loss, or a system crash.
bold	Bold text denotes items that you must select or click in the software, such as menu items and dialog box options. Bold text also denotes parameter names, controls and indicators on the front panel, dialog boxes, sections of dialog boxes, menu names, and palette names.
italic	Italic text denotes variables, emphasis, a cross-reference, or an introduction to a key concept. Italic text also denotes text that is a placeholder for a word or value that you must supply.
monospace	Monospace text denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames, and extensions.

Required Components

This section lists the software and hardware used in the *NI SoftMotion Module Tutorial* section of this document. This section also lists documents you may find helpful while completing the tutorial.

Required Software

The following software is required for this tutorial:

❑ LabVIEW 2009 or later

❑ LabVIEW 2009 Real-Time Module or later

❑ NI-RIO 3.2.0 or later

❑ LabVIEW 2009 NI SoftMotion Module or later

Required Hardware

The following hardware is required for this tutorial:

❑ CompactRIO controller and chassis that support the RIO Scan Interface

or

❑ NI 9144 distributed chassis and compatible real-time controller. Refer to the *Setting Up a Distributed System* section of this document for information about setting up and configuring the NI 9144 distributed chassis for use with the NI 951x modules.

❑ Two NI 9512 single-axis stepper drive interface modules

❑ Power supply for the controller

❑ A separate power supply for the modules

Note Refer to the hardware specifications for information about selecting an appropriate power supply.

❑ Ethernet connection and cable

Tip Even if you do not have the specified hardware, you can follow the steps in the *NI SoftMotion Module Tutorial* section of this document and perform offline configuration to learn concepts about using the NI SoftMotion Module with LabVIEW. Refer to the *Configuring a Project for a CompactRIO Reconfigurable or Integrated System (Scan Interface)* topic of the *LabVIEW Help* for information about offline configuration.

Alternatively, you can create an NI SoftMotion simulated axis. With a simulated axis you can create and execute motion applications without any hardware installed. Refer to the *Working with Simulated Axes* topic of the *NI SoftMotion Module Help* for more information about simulated axes.

Related Documentation

The following documents contain information that you may find helpful as you read this tutorial:

- Operating instructions for the controller and modules (shipped with the hardware and available at `ni.com/manuals`).

- *NI 951x User Manual*—Use this document to learn additional information about the electrical and mechanical aspects of the NI 951x C Series drive interface modules.

- *LabVIEW NI SoftMotion Module Help*—Use this help file to learn about using NI SoftMotion 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.

- *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**.

- *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**.

- *Getting Started with the LabVIEW Real-Time Module*—Use this document to learn how to develop a real-time project and VIs, from setting up RT targets to building, debugging, and deploying real-time applications. Access the *Getting Started with the LabVIEW Real-Time Module* PDF by selecting **Start»All Programs»National Instruments» LabVIEW»LabVIEW Manuals»RT_Getting_Started.pdf**.

- *CompactRIO Reference and Procedures (Scan Interface)*—Use this help file to learn about using the CompactRIO system in Scan Interface programming mode. To access this help file from LabVIEW, select **Help»LabVIEW Help**, then expand *Real-Time Module* on the **Contents** tab and select the *CompactRIO Reference and Procedures (Scan Interface)* book.

- *NI 9144 User Guide and Specifications*—Use this document to learn additional information about how to connect the NI 9144 chassis to a network, how to use the NI 9144 chassis features, and contains the NI 9144 chassis specifications.

- NI Industrial Communications for EtherCAT software documentation

NI SoftMotion Module Overview

The LabVIEW NI SoftMotion Module allows you to create deterministic motion control applications using the LabVIEW Real-Time Module and the RIO Scan Interface.

✎ **Note** This document covers using the NI 951x C Series modules with the RIO Scan Interface. For information about using the NI 951x modules with LabVIEW FPGA, refer to the *Motion Modules* book of the *LabVIEW Help*.

The following figure shows the NI SoftMotion architecture when you use the NI SoftMotion Module with NI 951x C Series drive interface modules and the RIO Scan Interface.
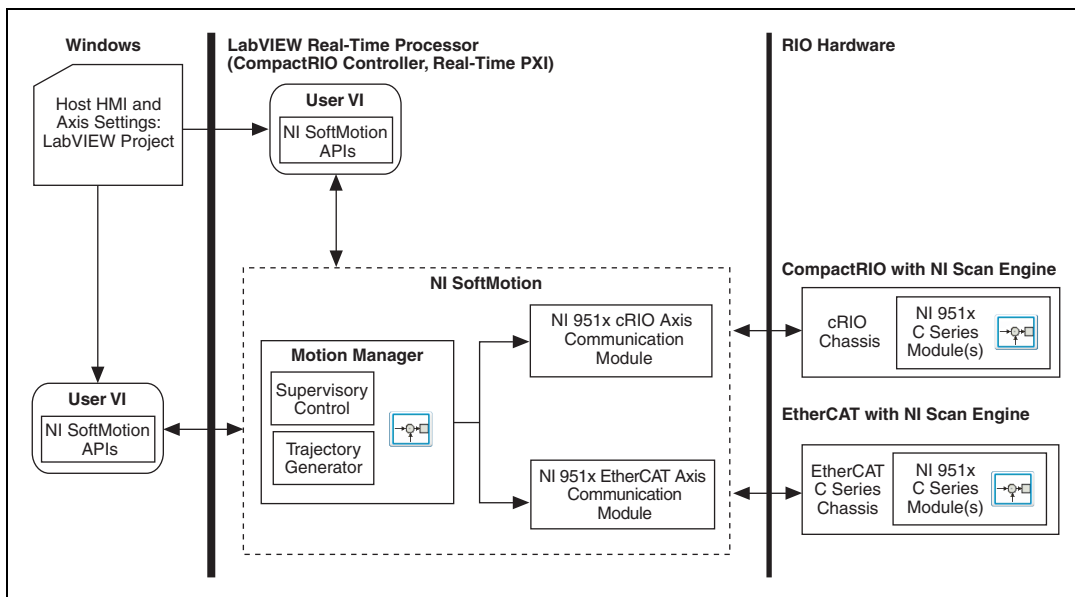
Figure 1. NI SoftMotion and NI 951x Module Architecture

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

The tutorial uses the NI SoftMotion function block API to create a VI. NI SoftMotion function blocks contain status inputs and outputs used to monitor and maintain the state of each individual function block. The function block API is a non-blocking, or asynchronous, API you use to communicate with your motion hardware. Refer to the *NI SoftMotion Help* book of the *LabVIEW Help* for more information about function block programming and other NI SoftMotion APIs.

NI SoftMotion Module Tutorial

This section contains a tutorial that uses the NI SoftMotion function blocks to perform a two axis move. You use two NI 9512 stepper drive interface modules in open-loop mode, so you are not required to make any additional feedback device or other hardware connections.

📝 **Note** The settings configured in this tutorial may not be appropriate for your actual motion system. Hardware connections are minimized for demonstration purposes. Refer to the *Connecting the NI 9512 to Hardware* section and the *Configuring and Connecting Servo Axes* section for more information about drive and I/O connections.

Setting Up the Hardware

Complete the following steps to set up the hardware for the application in this tutorial.

📝 **Note** This tutorial covers setting up NI 951x modules in a CompactRIO controller. If you are using an NI 9144 distributed chassis, refer to the *Setting Up a Distributed System* section for setup instructions.

1. Install the real-time CompactRIO controller on the FPGA backplane if you are not using an integrated controller and backplane. Refer to the controller operating instructions for information about installing the controller.

2. Install the NI 9512 modules in slot 1 and slot 2 of the chassis.

3. 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.

4. Connect the modules to a power supply. Refer to the module operating instructions for information about selecting an appropriate power supply.

5. Connect the module to a drive and other I/O, if available. Refer to Figure 11 for a simplified connection diagram.

📝 **Note** You cannot complete this tutorial if the module power supply is not connected.

Installing Software on and Configuring the Controller

Complete the following steps to configure the controller and install software on it. If you are setting up a distributed system using the NI 9144 distributed chassis, refer to the *Software Installation and Configuration With the NI 9144* section for software installation instructions.

1. Launch Measurement & Automation Explorer (MAX) on the development computer.

2. Select the controller under **Remote Systems** in the **Configuration** pane. If you do not see the controller, you may need to disable the firewall on the development computer.

3. Verify that the **Serial Number** in the **Identification** section matches the serial number on the device.

4. If you do not want to format the disk on the controller, eliminating all installed software and files, power on the controller and skip to step 12.

5. Set the **Safe Mode** switch on the controller to the **On** position.

6. Power on the controller. If it is already powered on, press the **Reset** button on the controller to reboot it.

7. Right-click the controller under **Remote Systems** in the **Configuration** pane and select **Format Disk**. Click **Yes** on the dialog box that appears.

8. When MAX finishes formatting the disk, set the **Safe Mode** switch to the **Off** position and press the **Reset** button on the controller to reboot it.

Note The following instructions apply to MAX 4.7 or later. Earlier versions of MAX may have slightly different settings names and locations.

9. Select the **System Settings** tab and type a descriptive name for the system in the **Name** field.

10. (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.

11. Click **Save** on the toolbar and let MAX reboot the system.

12. When the new system name appears under **Remote Systems**, expand the controller item in the tree, right-click **Software**, and select **Add/Remove Software**.

13. Select a recommended software set that includes NI-RIO 3.2.0 or later with NI Scan Engine Support and the following add-ons enabled:

   • LabVIEW NI SoftMotion Module

   • NI Scan Engine Support for LabVIEW NI SoftMotion Module

14. Click **Next** to install the selected software on the controller. Click **Help** if you need information about installing recommended software sets.

15. After MAX finishes installing software on the controller, close MAX.

Creating a Project in Scan Interface Mode

Scan Interface mode enables you to use C Series modules directly from LabVIEW Real-Time. Modules that you use in Scan Interface mode appear directly under the chassis item in the **Project Explorer** window. Unlike most C Series modules, NI 951x modules are not directly configurable from the **Project Explorer** window and no I/O variables are directly available under the module.

Tip Refer to the *Select Programming Mode Dialog Box* topic of the *CompactRIO Reference and Procedures (Scan Interface)* book of the *LabVIEW Help* for more information about Scan Interface mode.

Use a LabVIEW project to manage VIs, targets, and I/O modules on the development computer. Complete the following steps to create a LabVIEW project:

1. Launch LabVIEW.

2. Click the **Empty Project** link in the **Getting Started** window to display the **Project Explorer** window. You can also select **File»New Project** to display the **Project Explorer** window.

3. Select **Help** and make sure that **Show Context Help** is checked. You can refer to the context help throughout the tutorial for information about items on the block diagram.

4. Right-click the top-level project item in the **Project Explorer** window and select **New»Targets and Devices** from the shortcut menu to display the **Add Targets and Devices** dialog box.

5. Make sure that the **Existing target or device** radio button is selected.

Tip If you do not have hardware installed, you can select the **New target or device** radio button to display a list of targets and devices that you can create without a physical target or device present. Throughout this tutorial, you can perform similar offline configuration steps to follow along and learn about using the NI SoftMotion Module and LabVIEW.

6. Expand **Real-Time CompactRIO**.

7. Select the CompactRIO controller to add to the project and click **OK**.

8. If you have LabVIEW FPGA installed, the **Select Programming Mode** dialog box appears. Select **Scan Interface** to put the system into Scan Interface mode.

Tip Use the **CompactRIO Chassis Properties** dialog box to change the programming mode in an existing project. Right-click the CompactRIO chassis in the **Project Explorer** window and select **Properties** from the shortcut menu to display this dialog box.

9. Click **Discover** in the **Discover C Series Modules?** dialog box if it appears.

10. Click **Continue**. LabVIEW adds the controller, the chassis, and all the modules to the project.

✏️ **Note** If you are using an NI 9144 chassis, refer to the *Adding the EtherCAT Master Device To the LabVIEW Project* section for instructions about adding the EtherCAT master device and detecting the C Series modules.

11. When LabVIEW finishes discovering hardware, select **File»Save Project** and save the project as `951x_Tutorial.lvproj`.

When you have finished these steps your LabVIEW project should look similar to the image in Figure 2.

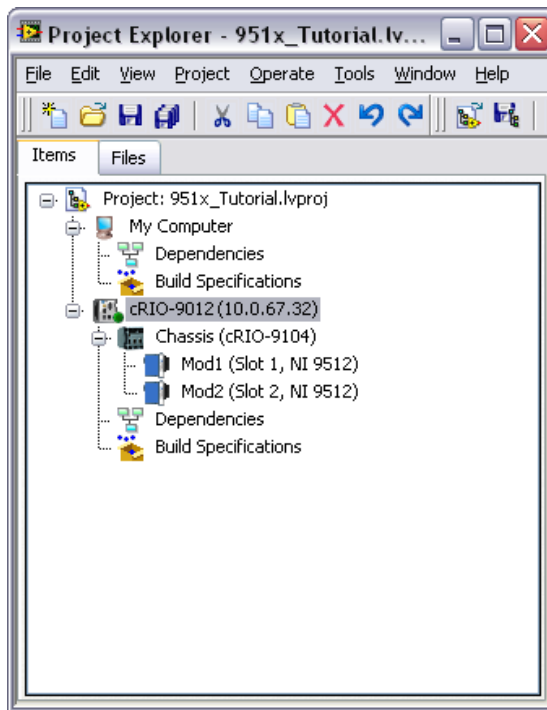**Figure 2.** Project Explorer Window with Modules in Scan Interface Mode

Adding NI SoftMotion Resources to the LabVIEW Project

In this section you will create NI SoftMotion I/O resources tied to the C Series modules. You use the NI SoftMotion I/O resources in your VIs instead of I/O variables. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for more information about motion I/O resources and NI SoftMotion.

Adding Axes to the Project

NI SoftMotion axes are tied to a specific C Series module in the project, and allow configuration of the I/O present on the module. To configure and use the NI 951x modules in Scan Interface mode you must add axes to the RT target and use the motion I/O resource associated with that axis in your VIs. Complete the following steps to add an NI SoftMotion axis to the project:

1. Right-click the target in the **Project Explorer** window and select **New»NI SoftMotion Axis** from the shortcut menu to open the **Axis Manager** dialog box, shown in Figure 3.

2. Click **Add New Axis** twice so that both NI 9512 modules are associated with NI SoftMotion axes. Axes are automatically bound to an available module. You can double-click the axis name to rename the axis and give it a descriptive name, but you cannot use the same name for two different axes.
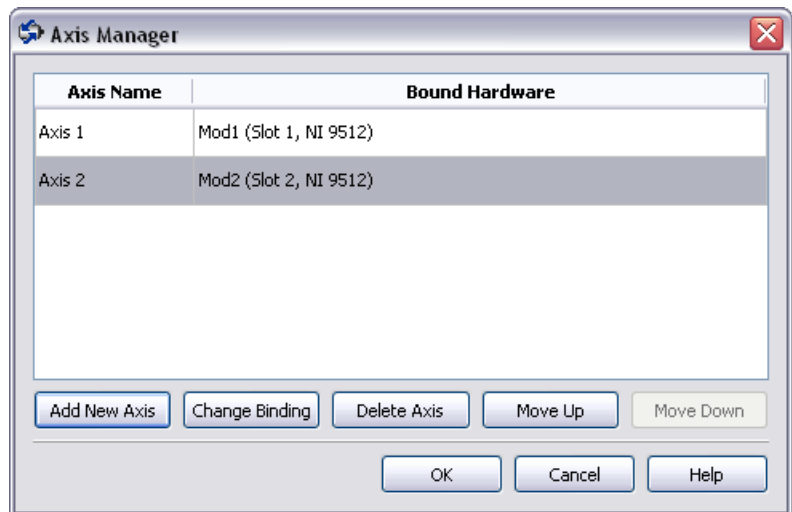

Figure 3. Axis Manager Dialog Box

💡 **Tip** Click **Change Binding** to open the **Resource Binding** dialog box and change the hardware the axis is associated with, if necessary.

3. Click **OK** to close the **Axis Manager** dialog box. All axes are added to the **Project Explorer** window.

📝 **Note** You cannot associate more than one axis with the same C Series module.

Adding Coordinates to the Project

NI SoftMotion axes can be grouped into coordinate spaces. Coordinate spaces are logical, multidimensional groups of axes. Like axes, coordinate spaces have associated I/O resources that you use as resource inputs in your VIs. Complete the following steps to add a coordinate space to the project:

1. Right-click the target in the **Project Explorer** window and select **New»NI SoftMotion Coordinate Space** from the shortcut menu to open the **Configure Coordinate Space** dialog box, shown in Figure 4.

2. Move **Axis 1** and **Axis 2** from the **Available Axes** column to the **Coordinate Axes** column using the arrow. Double-click the coordinate space name to rename the coordinate space and give it a descriptive name.

Figure 4. Configure Coordinate Space Dialog Box
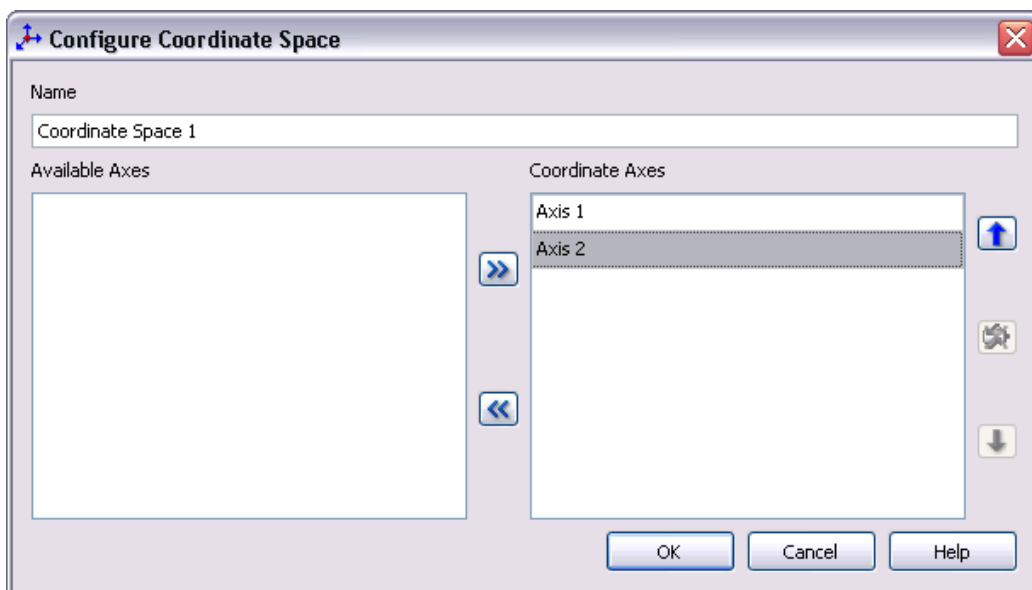
> **Note**   When using coordinate resources, target positions and other coordinate information are provided in a one-dimensional array with axis information provided in the order that axes are added using this dialog box. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for more information.

3. Click **OK** to close the **Configure Coordinate Space** dialog box.

Your project now contains the axes and coordinate spaces you will use in the application. Your LabVIEW project should look similar to Figure 5.
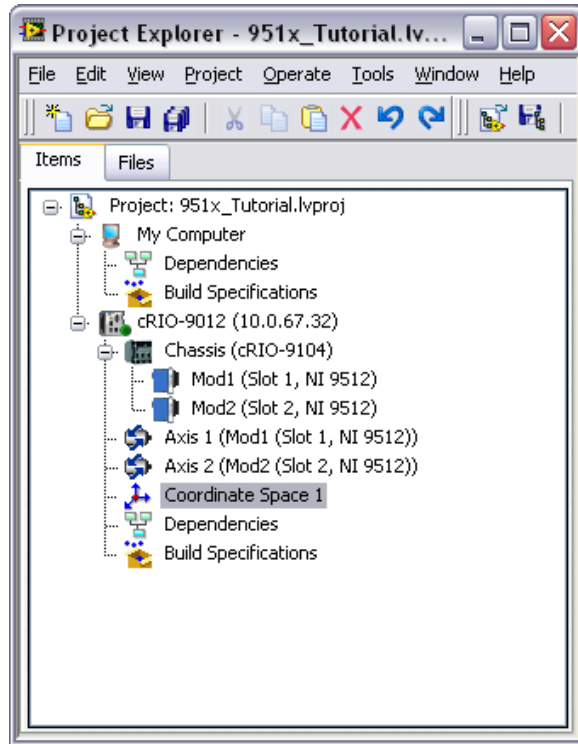

Figure 5. Completed Project with Motion Resources

Configuring Axes for Stepper Drive Interface Modules

In this section you will configure the axes associated with your NI 9512 C Series modules using the **Axis Configuration** dialog box.

Tip Refer to the *Configuring and Connecting Servo Axes* section of this document for information about configuring servo modules.

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 6 shows the parts of the **Axis Configuration** dialog box for NI 9512 C Series modules.
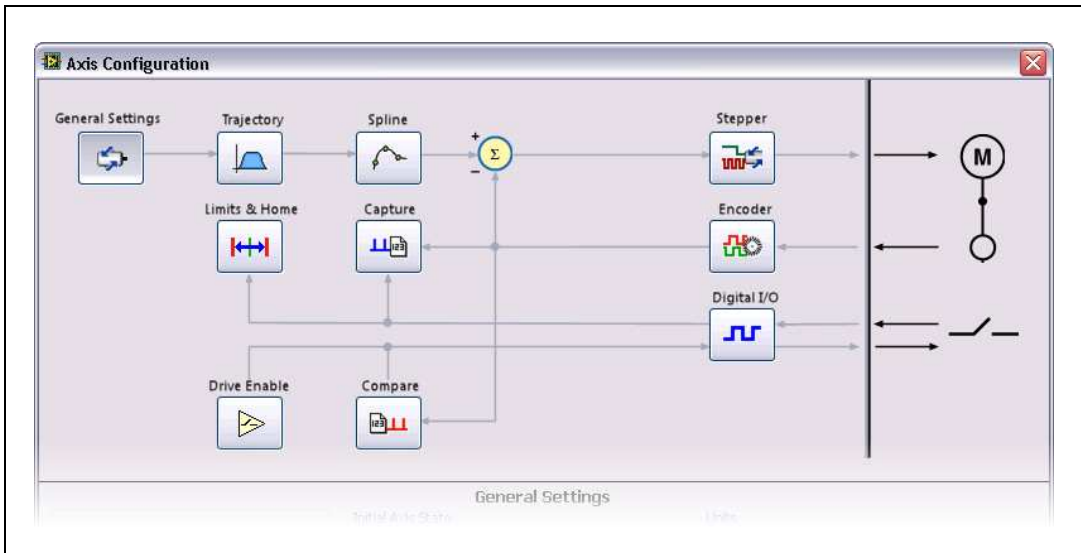

Figure 6. Axis Configuration Dialog Box for NI 9512 Modules

✎ **Note** Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for detailed information about each configuration option.

Complete the following steps to configure the axes. If you are configuring axes for a p-command drive, refer to Appendix B, *Position Command Connections*, in the *NI 951x User Manual* section of this document.

1. Right-click the axis in the **Project Explorer** window and select **Properties** from the shortcut menu to open the **Axis Configuration** dialog box.

2. On the **General Settings** page, confirm that **Loop Mode** is set to **Open-Loop**. Axes configured in open-loop mode produce step outputs but do not require feedback from the motor to verify position.

3. Also on the **General Settings** page, confirm that the **Axis Enabled** and **Enable Drive on Transition to Active Mode** checkboxes contain checkmarks. These selections configure the axes to automatically activate when the NI Scan Engine switches to Active mode.

✎ **Note** Disable these options to prevent axes from automatically activating when the NI Scan Engine switches to Active mode.

4. If the modules do not have physical limit and home input connections, you must disable these input signals for proper system operation. To disable limits and home, go to the **Limits & Home** page and remove the checkmarks from the **Enable** checkboxes in the **Forward Limit**, **Reverse Limit**, and **Home Switch** sections.

5. Configure any additional I/O settings according to your system requirements.

6. Click **OK** to close the **Axis Configuration** dialog box.

7. Repeat steps 1 through 6 for Axis 2.

⚠ **Caution** Make sure all hardware connections are made and power is turned on before deploying the project. Deployment switches the NI Scan Engine to Active mode and enables your axes and drive, if connected, so that you can start a move immediately. Refer to the *Deploying and Running VIs on an RT Target* topic of the *LabVIEW Help* for more information about deployment and for troubleshooting tips.

8. Right-click the controller item in the **Project Explorer** window and select **Deploy All** from the shortcut menu to deploy the axes, coordinate, and axis settings to the RT target.

Using the Interactive Test Panel

Use the Interactive Test Panel to test and debug your motion system and configuration settings on the selected axis. With the Interactive Test Panel you can perform a simple straight-line move and monitor move and I/O status information, change move constraints, get information about errors and faults in the system, and view position or velocity plots of the move. If you have a feedback device connected to your system, you can also obtain feedback position and position error information.

Complete the following steps to test your setup after configuring your axes using the **Axis Configuration** dialog box:

1. Right-click the axis in the **Project Explorer** window and select **Interactive Test Panel** from the shortcut menu.

2. Set the desired position, move mode, and move constraints using the tabs. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for detailed information about the items available in this dialog box.

3. Click the **Start** button on the bottom of the dialog box to start the move with the configured options.

4. Use the **Status** and **Plots** tabs to monitor the move while it is in progress.

Creating a VI in Scan Interface Mode

In this section you will create a VI that uses the NI SoftMotion axis and coordinate space I/O resources you created earlier. Refer to the *Real-Time Module* book of the *LabVIEW Help* for more information about Scan Interface mode and the NI Scan Engine.

Configuring the Timed Loop

A Timed Loop synchronized to the NI Scan Engine enables your time-sensitive motion function blocks to execute at the scan rate. Any code placed inside a Timed Loop is guaranteed to execute once per scan period, or at an interval you specify. Memory allocation should be minimized in Timed Loops to avoid introducing jitter into the system.

Tip If your application does not need to run at the scan rate, you can use a While Loop with a Wait Until Next ms Multiple function to control the loop rate.

Complete the following steps to configure the Timed Loop:

1. Right-click the controller item in the **Project Explorer** window and select **New»VI** from the shortcut menu to open a blank VI.

2. Place a Timed Loop on the block diagram of the VI.

3. Double-click the **Input Node** of the Timed Loop to open the **Configure Timed Loop** dialog box.

4. Under **Loop Timing Source**, for **Source Type**, select **Synchronize to Scan Engine**. You can click the **Help** button for information about synchronizing to the NI Scan Engine.

5. Under **Loop Timing Attributes**, set the **Period** to **5** scans. This step is optional but allows the Timed Loop to execute synchronized to the NI Scan Engine but at a slower rate.

The **Configure Timed Loop** dialog box should look similar to the following figure.
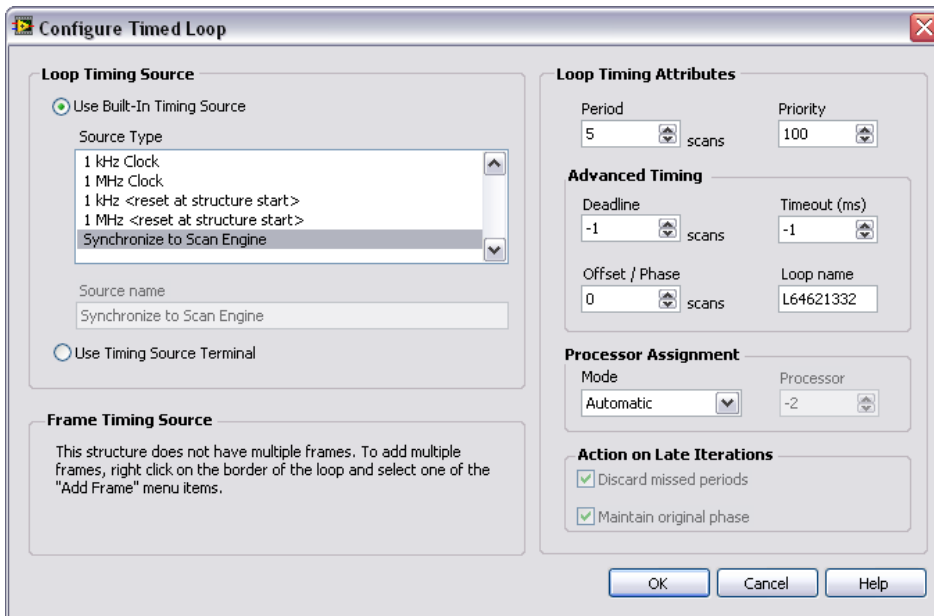

Figure 7. Configuring the Timed Loop

6. Click **OK**.

Creating a Move Profile

This example uses the NI SoftMotion Line and Read function blocks to create a simple move profile and monitor the position during the move.

💡 **Tip** The NI SoftMotion palette is not visible by default. Refer to the *Showing and Hiding Palette Categories* topic in the *LabVIEW Help* for information about editing the palette view to make the NI SoftMotion function blocks more accessible. Complete the following steps to set up the move:

1. Place a Line function block inside the Timed Loop. The NI SoftMotion function blocks are located on the **NI SoftMotion»Advanced** palette.

2. Drag the **Coordinate Space 1** resource from the LabVIEW Project on to the block diagram outside the Timed Loop and wire it to the **resource** input on the function block.

3. Right-click the **execute** input and select **Create»Control** from the shortcut menu to add a control to the front panel for this input.

4. Repeat step 3 for the **position**, **velocity**, and **acceleration** inputs to add controls to the front panel for each of these inputs.

5. Place a second Line function block inside the Timed Loop.

6. Wire the error terminals and resource terminals of the Line function blocks together.

7. Wire the **done** output of the first Line function block to the **execute** input of the second Line function block.

8. Wire the **velocity** and **acceleration** inputs of the second Line function block to the controls created in step 3. This configures the second function block to use the same move constraint values as the first function block.

9. Right-click the **position** input and select **Create»Control** from the shortcut menu to add a control for the second position to the front panel.

10. Add a Read function block to the block diagram and connect the resource input to the **Coordinate Space 1** resource.

![note icon] **Note** Reading the position and plotting is generally executed on the host by reading data published by the target and not in the deterministic Timed Loop. Reading is included in this example for simplicity.

11. Add a Merge Errors function to the block diagram and wire the **error out** outputs of the Read function block and second Line function block to the Merge Errors function.

12. Right-click the **error out** output of the Merge Errors function and select **Create»Indicator** from the shortcut menu to add an indicator to the front panel.

13. Wire the **error out** output to the edge of the Timed Loop.

14. Right-click the loop tunnel created for the **error out** output and select **Replace with Shift Register** from the shortcut menu. This transfers the error information to the next loop iteration.

15. Wire the **error in** inputs of the Line and Read function blocks to the shift register created on the other side of the Timed Loop.

16. Right-click the shift register and select **Create»Constant** from the shortcut menu to initialize the error cluster outside the Timed Loop. Because the hardware uses the LabVIEW Real-Time module, all function block arrays and clusters are initialized outside the Timed Loop to prevent jitter in the system.

17. Create a constant for the **position[ ]** input on the Read function block and enter 0 for the first two elements of the array. Move the **position[ ]** constant outside the Timed Loop. This initializes the array so that the function block does not need to allocate any memory.

18. Right-click the Timed Loop conditional terminal and select **Create»Control** from the shortcut menu to add a Stop button to the front panel. This allows you to stop execution of the VI at any time.

    Your block diagram should look similar to the following when you have completed these steps:
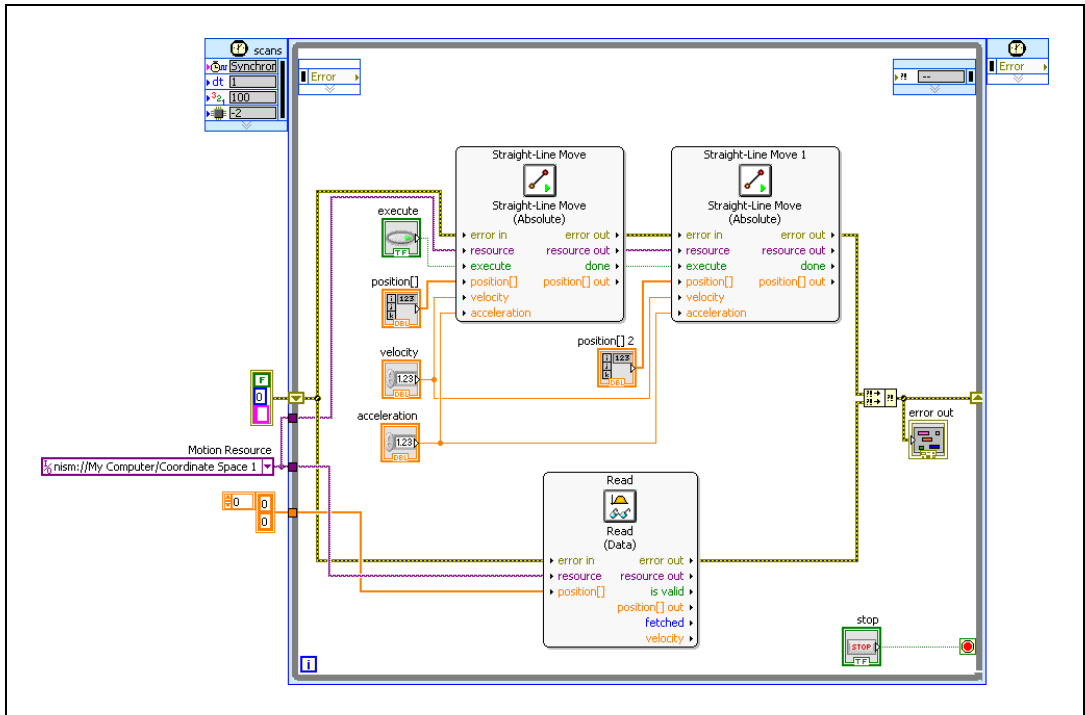

Figure 8. Block Diagram

19. Switch to the front panel.

20. In the **position[]** array, enter 5000 for the first two elements of the array. This specifies an x, y position of 5000, 5000.

21. In the **position[] 2** array, enter 0 for the first two elements of the array. This moves the x and y axis back to 0, 0.

22. Keep the velocity and acceleration values at their defaults for now.

23. Add a waveform chart to the front panel.

24. Switch to the block diagram, move the waveform chart indicator into the Timed loop if necessary, then connect the **position[] out** terminal from the Read function block to the waveform chart indicator.

Your front panel should look similar to the following when you have completed these steps:
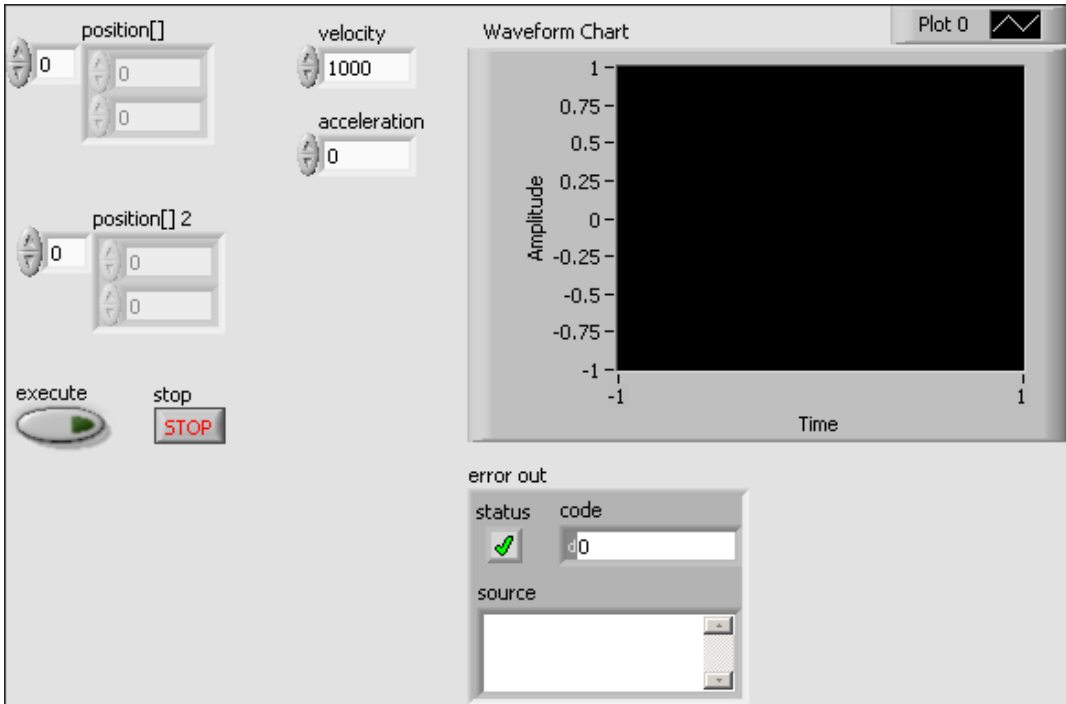
Figure 9. Front Panel

25. Save the VI.
26. Save the project.

Deploying, Testing, and Using the VI

Complete the following steps to deploy, test, and use the VI:

1. Run the VI. LabVIEW deploys the VI, and all modules and I/O variables the VI uses, to the controller.
2. Pulse the **execute** control to start execution.
3. On the front panel, verify that the position graph updates.
4. Stop the VI by clicking the **Stop** button.
5. Change any of the input parameters, run the VI, and pulse **execute** again to see how the different parameters interact.

What You Have Learned

This tutorial taught the following concepts about developing motion applications using the NI SoftMotion Module and NI 951x C Series modules.

- NI 951x modules differ from most C Series modules in that they are not directly configurable from the **Project Explorer** window when you are using Scan Interface mode, and no I/O variables are directly available under the module.

- You must use NI SoftMotion to add axes to the RT target and associate them with NI 951x modules in order to configure and use them in Scan Interface mode. You then use the motion I/O resources associated with those axes in your VIs.

- NI SoftMotion axes are configured using the **Axis Configuration** dialog box.

- NI SoftMotion function blocks allow you to create deterministic motion control applications using the function block programming paradigm.

- NI SoftMotion function blocks provide status outputs for advanced state monitoring.

Connecting the NI 9512 to Hardware

This section describes how to connect the NI 9512 stepper drive interface module to third-party drives using the NI 951x Cable and Terminal Block bundle.

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

Table 1. NI 9512 Connection Options

Drive	Connection Option
P7000 Series Stepper	NI 9512 to P7000 Stepper Drive Connectivity Bundle (NI part number 780552-01) **Note**: Refer to *Getting Started with NI 9512 C Series Drive Interface Modules and P7000 Series Stepper Drives*, available by selecting **Start»All Programs»National Instruments»LabVIEW» LabVIEW Manuals»Getting_Started_NI_9512_P7000.pdf** and on `ni.com/manuals`, for information about connecting and using the NI 9512 module with P7000 series stepper drives and stepper motors available from NI.
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.

Table 1. NI 9512 Connection Options (Continued)

Drive	Connection Option
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.
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 Connections*, in the *NI 951x User Manual* available by selecting **Start»All Programs» National Instruments»NI-RIO»CompactRIO»CompactRIO Manuals»NI_951x_User_Manual.pdf** and on `ni.com/manuals`, for information about connecting and using the NI 9512 module with other p-command servo drives.

Connecting to Drives Using the 37-Pin Terminal Block

Note Refer to the *NI 951x User Manual* for 37-pin terminal block pinouts for each module.

Complete the following steps to connect an NI 9512 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 the 37-pin terminal block using the NI 951x 37-pin terminal block cable.

3. Make the following connections from the 37-pin terminal block to the external hardware device:

   a. Connect the Step and Direction outputs to the stepper drive.

   b. Connect the Drive Enable output to the stepper drive.

   c. Connect the Forward Limit, Reverse Limit, and Home inputs on the terminal block to the limit and home sensors.

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

   d. Connect the module power supply to one of the power supply inputs on either the DSUB or MDR connector.

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.

   e. Connect any additional I/O using the provided terminals.

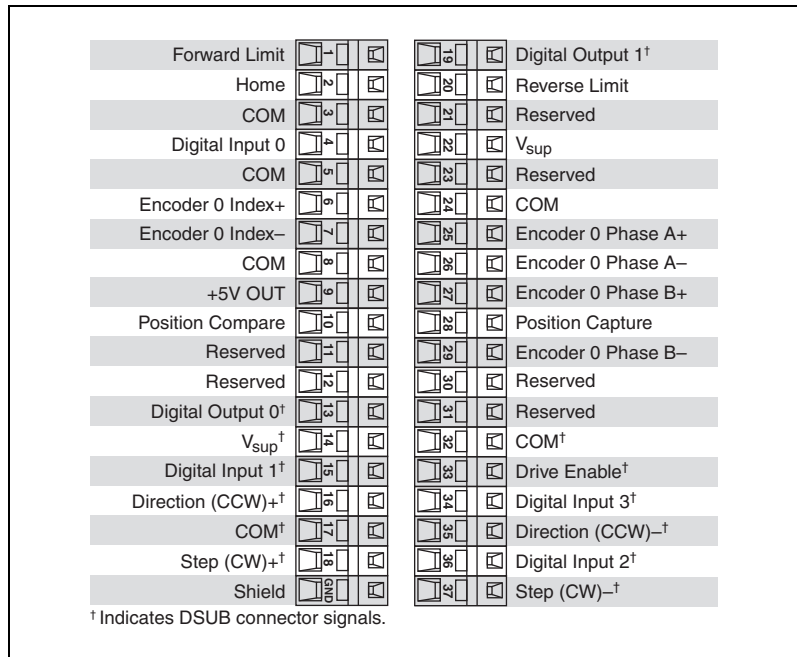   Figure 10 shows the NI 9512 37-pin terminal block pinout.

Forward Limit — 1	19 — Digital Output 1[†]
Home — 2	20 — Reverse Limit
COM — 3	21 — Reserved
Digital Input 0 — 4	22 — V_{sup}
COM — 5	23 — Reserved
Encoder 0 Index+ — 6	24 — COM
Encoder 0 Index– — 7	25 — Encoder 0 Phase A+
COM — 8	26 — Encoder 0 Phase A–
+5V OUT — 9	27 — Encoder 0 Phase B+
Position Compare — 10	28 — Position Capture
Reserved — 11	29 — Encoder 0 Phase B–
Reserved — 12	30 — Reserved
Digital Output 0[†] — 13	31 — Reserved
V_{sup}[†] — 14	32 — COM[†]
Digital Input 1[†] — 15	33 — Drive Enable[†]
Direction (CCW)+[†] — 16	34 — Digital Input 3[†]
COM[†] — 17	35 — Direction (CCW)–[†]
Step (CW)+[†] — 18	36 — Digital Input 2[†]
Shield — GND	37 — Step (CW)–[†]

[†] Indicates DSUB connector signals.

Figure 10. NI 9512 37-Pin Terminal Block Pin Assignments

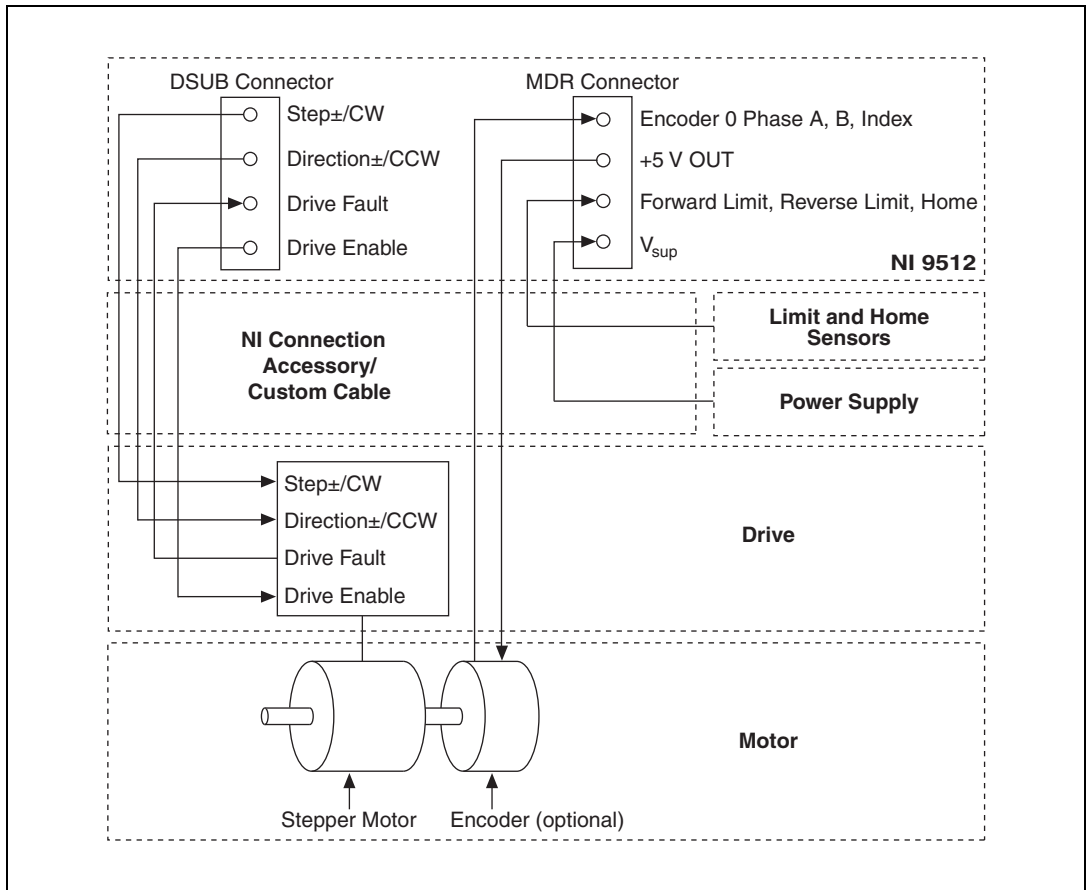Figure 11 shows a simplified connection diagram.

Figure 11. NI 9512 Connection Diagram

4.   Install software on your controller, create a LabVIEW project, and add NI SoftMotion axes by following the steps provided in the *NI SoftMotion Module Tutorial* section of this document.

5.   Right-click the axis in the **Project Explorer** window and select **Properties** from the shortcut menu to open the **Axis Configuration** dialog box.

6.   Configure your I/O settings according to your system requirements using the **Axis Configuration** dialog box.

Configuring and Connecting Servo Axes

This section provides additional information about configuring the NI 9514 and NI 9516 servo drive interface modules and connecting to drives and other I/O using the NI 951x Cable and Terminal Block bundle.

✏️ **Note** Refer to *Getting Started with NI 9514/16 C Series Drive Interface Modules and AKD Analog Servo Drives*, available by selecting **Start»All Programs» National Instruments»LabVIEW»LabVIEW Manuals» Getting_Started_NI_9514_NI_9516_AKD.pdf** and on ni.com/manuals, for information about connecting and using the NI 9514 and NI 9516 module with AKD analog servo drives and AKM brushless servo motors available from NI.

Complete the following steps to connect an NI 9514 or 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 the 37-pin terminal block using the NI 951x 37-pin terminal block cable.

Figures 12 and 13 show the NI 9514 and NI 9516 37-pin terminal block pinouts, respectively.

Signal	Pin			Pin		Signal
Forward Limit	1			19		Reserved
Home	2			20		Reverse Limit
COM	3			21		Reserved
Digital Input 0	4			22		V_{sup}
COM	5			23		Reserved
Encoder 0 Index+	6			24		COM
Encoder 0 Index–	7			25		Encoder 0 Phase A+
COM	8			26		Encoder 0 Phase A–
+5V OUT	9			27		Encoder 0 Phase B+
Position Compare	10			28		Position Capture
Reserved	11			29		Encoder 0 Phase B–
Drive Command†	12			30		Reserved
Reserved	13			31		Drive Command COM†
V_{sup}†	14			32		COM†
Digital Input 1†	15			33		Drive Enable†
Reserved	16			34		Reserved
COM†	17			35		Reserved
Reserved	18			36		Reserved
Shield	GND			37		Reserved

† Indicates DSUB connector signals.

Figure 12. NI 9514 37-Pin Terminal Block Pin Assignments

Signal	Pin			Pin		Signal
Forward Limit	1			19		Reserved
Home	2			20		Reverse Limit
COM	3			21		Encoder 1 Phase A+
Digital Input 0	4			22		V_{sup}
Encoder 1 Phase B–	5			23		Encoder 1 Phase A–
Encoder 0 Index+	6			24		Encoder 1 Phase B+
Encoder 0 Index–	7			25		Encoder 0 Phase A+
COM	8			26		Encoder 0 Phase A–
+5V OUT	9			27		Encoder 0 Phase B+
Position Compare	10			28		Position Capture
Reserved	11			29		Encoder 0 Phase B–
Drive Command†	12			30		Reserved
Reserved	13			31		Drive Command COM†
V_{sup}†	14			32		COM†
Digital Input 1†	15			33		Drive Enable†
Reserved	16			34		Reserved
COM†	17			35		Reserved
Reserved	18			36		Reserved
Shield	GND			37		Reserved

† Indicates DSUB connector signals.

Figure 13. NI 9516 37-Pin Terminal Block Pin Assignments

3. Make the following connections from the 37-pin terminal block to the external hardware device:

   a. Connect the Drive Command output to the servo drive.

   b. Connect the Drive Enable output to the servo drive.

   c. Connect the encoder inputs to the encoder.

   d. Connect the Forward Limit, Reverse Limit, and Home inputs on the terminal block to the limit and home sensors.

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

   e. Connect the module power supply to one of the power supply inputs on either the DSUB or MDR connector.

Note The NI 9514 and NI 9516 modules require 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.

   f. Connect any additional I/O using the provided terminals.

Figure 14 shows a simplified connection diagram.
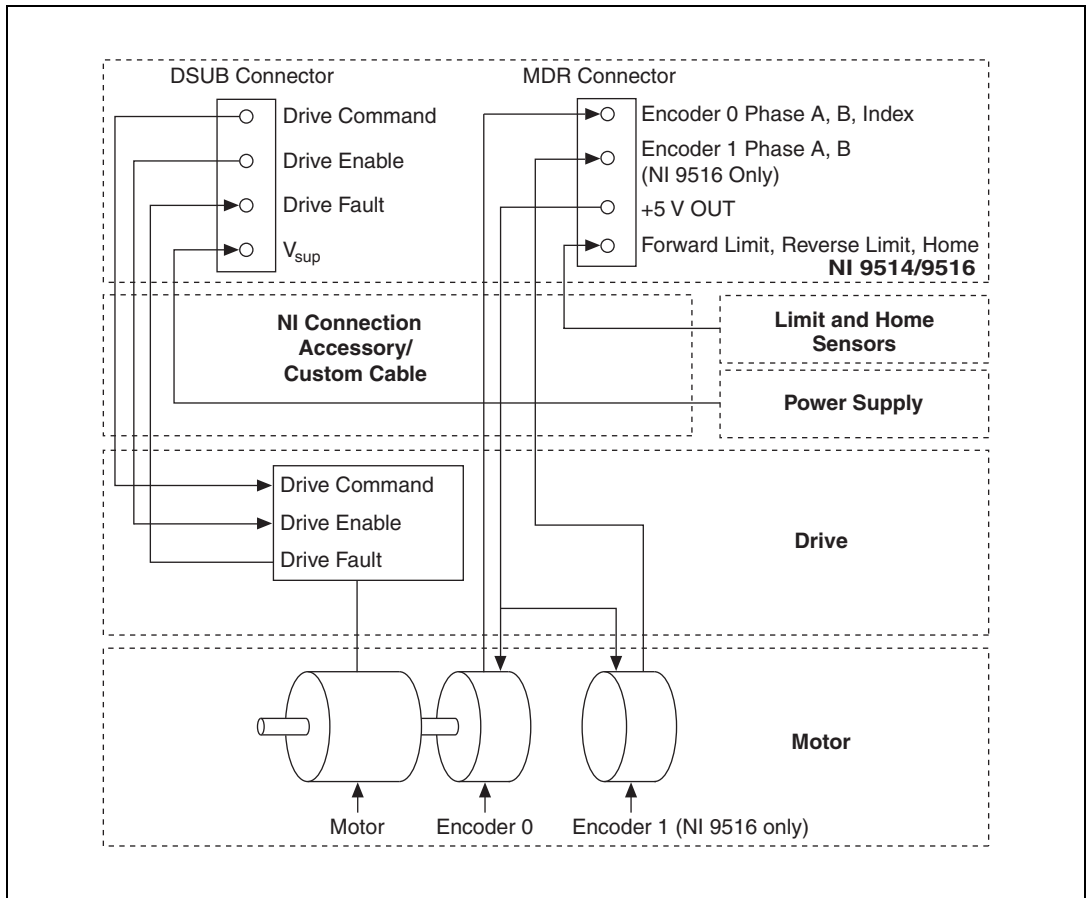
Figure 14. NI 9514 and NI 9516 Connection Diagram

✎ **Note** Refer to the *NI 951x User Manual* for connection diagrams specific to each NI 951x module.

4. Install software on your controller, create a LabVIEW project, and add NI SoftMotion axes by following the steps provided in the *NI SoftMotion Module Tutorial* section of this document.

5. Right-click the axis in the **Project Explorer** window and select **Properties** from the shortcut menu to open the **Axis Configuration** dialog box.

   Servo axes only operate in closed-loop mode, so a feedback device is required. If you are using an NI 9514 or NI 9516 drive interface module you must configure additional options for the feedback device, servo control loop, and drive command output for the servo drive.

Figure 15 shows the parts of the **Axis Configuration** dialog box for NI 9514 and NI 9516 C Series modules.
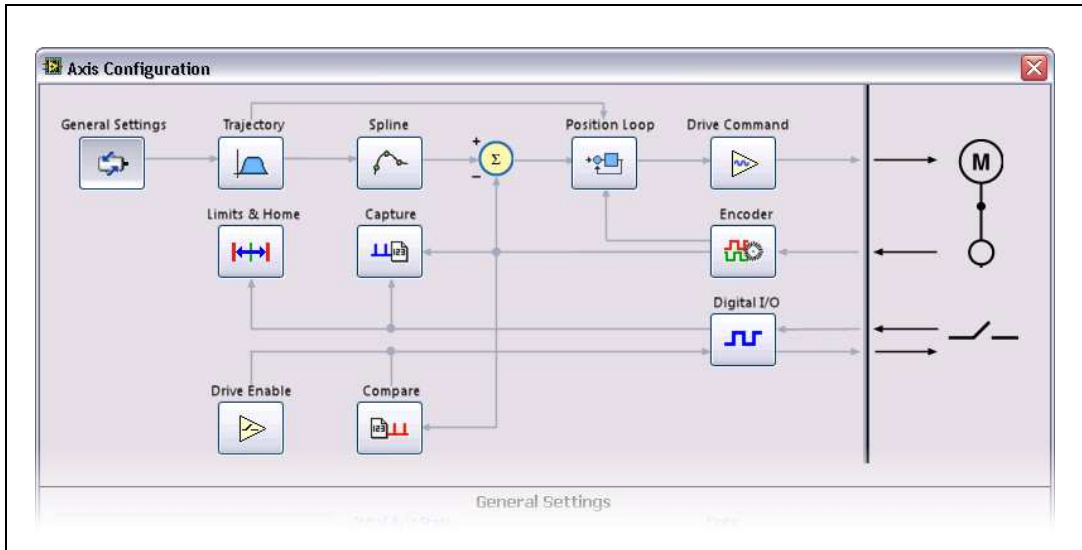
Figure 15. Axis Configuration Dialog Box for NI 9514 and NI 9516 Modules

6. Configure your I/O settings according to your system requirements using the **Axis Configuration** dialog box.

7. Right-click the axis in the **Project Explorer** window and select **Gain Tuning Panel** from the shortcut menu to access the Gain Tuning Panel.

8. Use the Gain Tuning Panel to tune the control loop settings and determine the relative stability of the servo axis. Refer to the *Using the Gain Tuning Panel* topic in the *NI SoftMotion Module* book of the *LabVIEW Help* for detailed information about the Gain Tuning Panel and servo system tuning instructions.

Setting Up a Distributed System

Setting Up a System With An NI 9144 Chassis

Complete the following steps to set up the EtherCAT master and configure the distributed network for use with the NI 9144:

1. Install the real-time controller into the CompactRIO or PXI system.

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.

3. Connect the secondary port of your EtherCAT Master directly to the IN port (top port) on the NI 9144 chassis using a standard Category 5 Ethernet cable. If you are using the NI cRIO-9074 as your EtherCAT Master, the secondary port is top port (LAN PORT #2). If you are using a PXI system, you must add a PXI-8231/8232 network card for the secondary port. You may expand the deterministic Ethernet network by connecting an additional NI 9144 chassis or other slave devices to the OUT port (bottom port) on the first NI 9144 chassis.
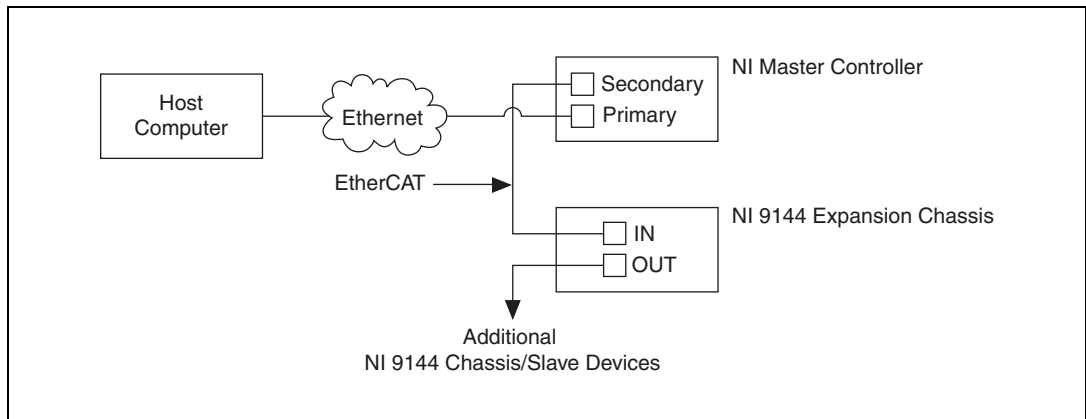
Figure 16. Connecting the NI 9144 Chassis to Network

4. Install the NI 9512 modules in slot 1 and slot 2 of the NI 9144 chassis.

Note The NI 9512 modules require high-speed interface slots. Some chassis may support the high-speed interface in additional slots. Refer to ni.com for more information.

5. Connect the modules to a power supply. Refer to the module operating instructions for information about selecting an appropriate power supply.

Note You cannot complete this tutorial if the module power supply is not connected.

6. If using the NI 9144 chassis with a PXI master controller, disable **Legacy USB Support** in the host PC BIOS, if it is enabled.

7. Connect the module to a drive and other I/O, if available.

8. Continue with the *Software Installation and Configuration With the NI 9144* section.

Software Installation and Configuration With the NI 9144

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

1. Launch Measurement & Automation Explorer (MAX) on the development computer by clicking the MAX icon on the desktop, or by selecting **Start»All Programs»National Instruments» Measurement & Automation**.

2. Select the controller under **Remote Systems** in the **Configuration** pane. If you do not see the controller, you may need to disable the firewall on the development computer.

3. Verify that the **Serial Number** in the **Identification** section matches the serial number on the device.

4. If you do not want to format the disk on the controller, eliminating all installed software and files, power on the controller and skip to step 12.

5. Set the **Safe Mode** switch on the controller to the **On** position.

6. Power on the controller. If it is already powered on, press the **Reset** button on the controller to reboot it.

7. Right-click the controller under **Remote Systems** in the **Configuration** pane and select **Format Disk**. Click **Yes** on the dialog box that appears.

8. When MAX finishes formatting the disk, set the **Safe Mode** switch to the **Off** position and press the **Reset** button on the controller to reboot it.

9. Select the **System Settings** tab and type a descriptive name for the system in the **Name** field.

10. (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.

11. Click **Save** on the toolbar and let MAX reboot the system.

12. When the new system name appears under **Remote Systems**, expand the controller item in the tree, right-click **Software**, and select **Add/Remove Software**.

13. Select a recommended software set that includes NI-RIO 3.4.0 or later with NI Scan Engine Support and the following add-ons enabled:

   • LabVIEW NI SoftMotion Module

   • NI Scan Engine Support for LabVIEW NI SoftMotion Module

   • IndCom for EtherCAT Scan Engine Support

14. Click **Next** to install the selected software on the controller. Click **Help** if you need information about installing recommended software sets.

15. When MAX finishes installing the software on the controller, select the controller under Remote Systems in the Configuration pane.

16. Click the **Network Settings** tab and expand **More Settings** in the **eth1** section

17. Select **EtherCAT** from the **Adapter Mode** list.

Note These settings are not available if NI-Industrial Communications for EtherCAT is not installed.

18. In the **eth0 (Primary)** section click **More Settings** and change **Packet Detection** to **Polling**. Leave the **Polling Interval** at 1 ms.

When you have completed these steps the **Network Settings** tab will look similar to Figure 17.

Figure 17. Network Settings Tab

19. Click **Save**.
20. Close MAX.
21. Continue with the *Creating a Project in Scan Interface Mode* section.

Adding the EtherCAT Master Device To the LabVIEW Project

If you are using the NI 9144 chassis, complete the following steps to add the EtherCAT master device and detect the C Series modules:

1. In the LabVIEW **Project Explorer** window, right-click the master controller and select **New»Targets and Devices**.

2. In the **Add Targets and Devices** dialog window shown in Figure 18, select **Existing target or device** and expand the category EtherCAT Master Device to auto-discover the EtherCAT port on the master controller. An EtherCAT master device and modules can be added manually at any time.
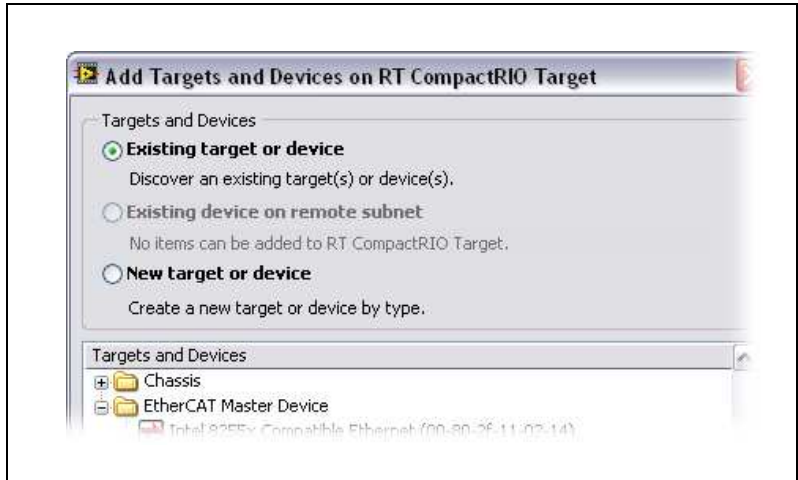
Figure 18. Adding the EtherCAT Master

When all the slave devices are discovered, the LabVIEW **Project Explorer** window lists each slave device and any installed C Series modules.

3. For more information about configuring the deterministic Ethernet network, the NI 9144 chassis, and the C Series modules, refer to the *Related Documentation* section of this document.

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, 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.