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**NI-9144**

# GETTING STARTED

# NI 9512 C Series Modules and AKD Servo Drives



**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 install and configure the AKD servo drives for use with the NI 9512 C Series drive interface module.



**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

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**Caution** Before installing the drive, review Chapter 2, *Safety*, in the *AKD Installation Manual* that came with your hardware or available from [ni.com/manuals](http://ni.com/manuals). Failure to follow safety instructions may result in injury or damage to equipment.

You need the following items to get started.

### Hardware

- ☐ NI 9512 C Series stepper drive interface module
- ☐ NI real-time controller
  - CompactRIO controller and chassis that support the RIO Scan Interface



**Tip** To determine if your controller and chassis support the RIO Scan Interface go to [ni.com/info](http://ni.com/info) and enter the Info Code `rdsoftwareversion`.

or

- NI 9144 distributed chassis and compatible RT controller
- ☐ Power supply for the CompactRIO controller
- ☐ +24 VDC power supply for the drive interface module and AKD servo drive
- ☐ Ethernet connection and cable for the CompactRIO controller
- ☐ Ethernet connection and cable for the AKD servo drive
- ☐ NI 9512 to AKD Drive Cable

- ☐ AKD servo drive
- ☐ NI or third-party servo motor and encoder



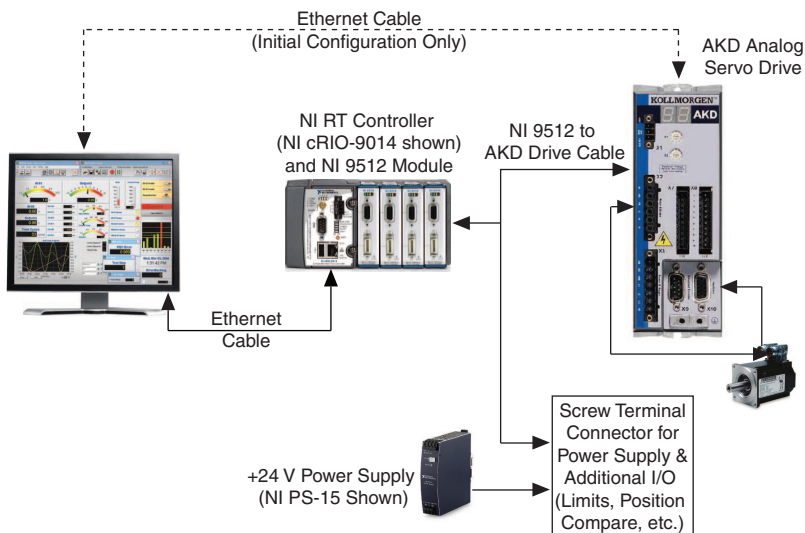
**Note** AKM series servo motors available from NI contain built-in encoders and come pre-wired for use with the AKD servo drive. National Instruments recommends using one of these motors for the best user experience and system performance.

## Software

- ☐ LabVIEW 2009 SP1 or later
- ☐ LabVIEW 2009 SP1 Real-Time Module or later
- ☐ LabVIEW 2009 SP1 NI SoftMotion Module or later
- ☐ NI-RIO 3.4.0 or later
- ☐ NI-Industrial Communications for EtherCAT® 1.2 or later, if you are using the NI 9144 distributed chassis
- ☐ AKD WorkBench software. Refer to [Step 1: Install Software on and Configure the NI RT Controller](#) in the [Software Installation and Configuration](#) section of this document for installation information.

Figure 1 shows the required hardware and software.

**Figure 1. Required Hardware and Software**



## Related Documentation

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](http://ni.com/manuals).

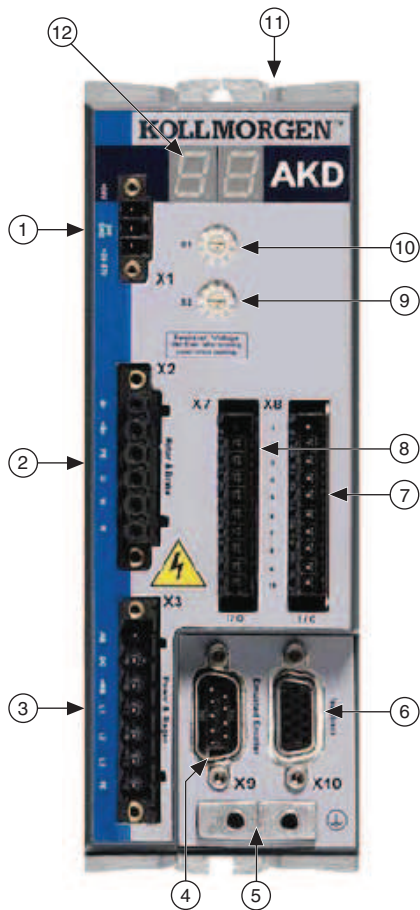
- Operating instructions for the controller and C Series module.
- *AKD Installation Manual*—Use this document to learn additional information about the electrical and mechanical aspects of the AKD servo drive, including important safety information.
- *Getting Started with NI 951x C Series Modules and LabVIEW*—Use this document to learn about using the NI 951x modules with LabVIEW, including information about the LabVIEW NI SoftMotion Module. To access this document, select **Start»All Programs»National Instruments»LabVIEW»LabVIEW Manuals»Getting\_Started\_NI\_951x\_Modules\_LabVIEW.pdf**.
- *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.
- *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
- *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**.

# Hardware Installation and Configuration

This section covers the hardware setup for the CompactRIO system, NI 9512 C Series module, and AKD servo drive.

Figure 2 shows an overview of the connectors on the AKD servo drive.

**Figure 2.** AKD Servo Drive Connectors



1	24 V Supply, STO (X1)	5	Drive Grounding Lug	9	Static IP Addressing Switch (S2)
2	Motor, Brake (X2)	6	Feedback (X10)	10	Static IP Addressing Switch (S1)
3	AC Input Power (X3)	7	I/O Connector (X8)	11	Drive Communication (X11)
4	Encoder Emulation (X9)	8	I/O Connector (X7)	12	LED Indicators

# Step 1: Set Up the CompactRIO System

Complete the following steps to set up the CompactRIO hardware.



**Note** If you are using an NI 9144 chassis, refer to [Setting Up a System with an NI 9144 Chassis](#) in the [Setting Up a Distributed System](#) section for alternate configuration instructions, then continue with [Step 2: Connect NI 9512 to AKD Drive Cable to the C Series Module](#).

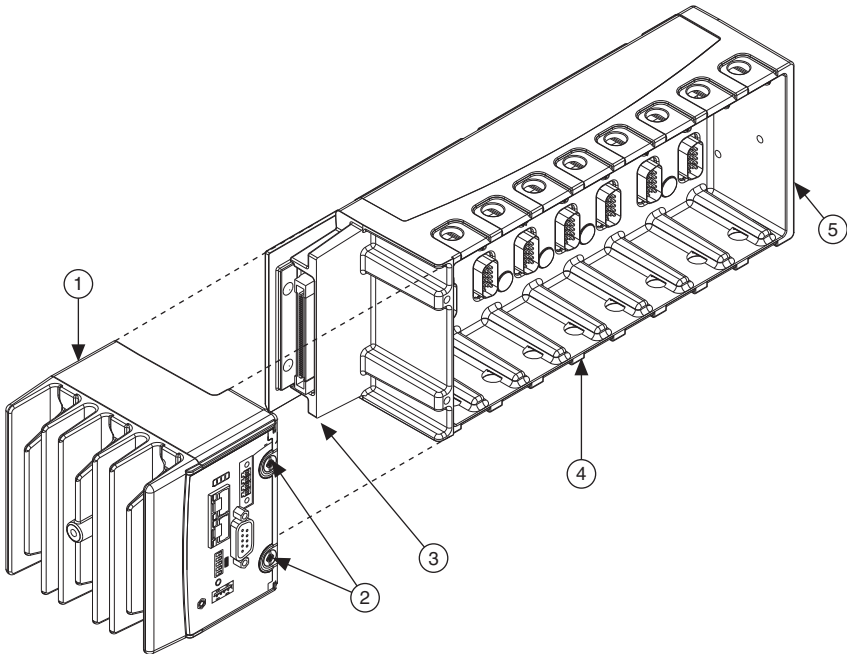
1. Install the real-time CompactRIO controller on the chassis if you are not using an integrated controller and chassis.



**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.



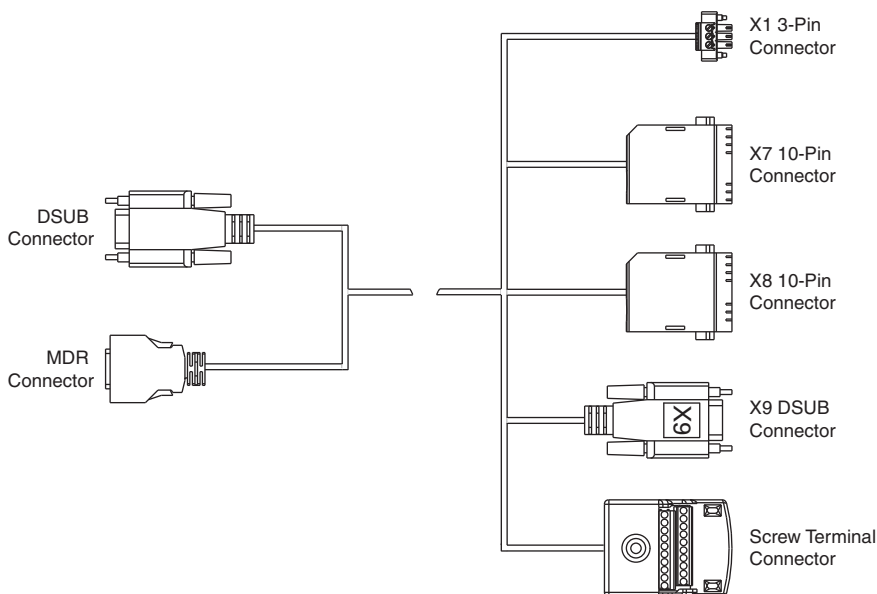
**Note** Do not plug in or turn on any power to the system until after you complete *Step 8: Connect the Drive Communication*.

3. Install the NI 9512 module in slot 1, 2, 3, or 4 of the chassis.

## Step 2: Connect NI 9512 to AKD Drive Cable to the C Series Module

Connect the MDR and DSUB connectors on the NI 9512 to AKD Drive Cable to the MDR and DSUB connectors on the C Series module. Figure 4 shows the NI 9512 to AKD Drive Cable connectors.

**Figure 4.** NI 9512 to AKD Drive Cable Connectors





The NI 9512 to AKD Drive Cable contains the following connections:

- **DSUB Connector**—15-pin DSUB connector containing drive command and drive enable signals.
- **MDR Connector**—20-pin MDR connector containing encoder, limit, home sensor, position compare, and position capture signals.
- **X1 3-pin Connector**—+24 V power supply connection for the AKD servo drive provided through the 20-pin screw terminal connector.
- **X7 10-Pin Connector**—10-pin connector containing the step/direction signals and AKD digital outputs.
- **X8 10-Pin Connector**—10-pin connector containing the enable and fault signals.
- **X9 DSUB Connector**—9-pin DSUB connector containing emulated encoder output signals from the AKD servo drive.
- **Screw Terminal Connector**—20-pin screw terminal connector for external I/O connections.

Table 1 shows the screw terminal connector pinout.

**Table 1.** NI 9512 to AKD Drive Cable Screw-Terminal Pinout

Pin	Signal Name
1	Forward Limit
2	Home
3	Reverse Limit
4	NI 9512 Digital Input 0
5	Vsup
6	Vsup Return
7	NI 9512 Digital Output 0
8	NI 9512 Digital Output 1
9	NC†
10	NC†
11	NI 9512 +5V OUT
12	Position Compare
13	Position Capture
14	COM
15	Reserved
16	Reserved

**Table 1.** NI 9512 to AKD Drive Cable Screw-Terminal Pinout (Continued)

Pin	Signal Name
17	Reserved
18	Reserved
19	Reserved
20	Reserved
† NC = Not Connected	

## Step 3: Mount the Drive and Connect the Protective Earth

1. Mount the drive to a conductive metal plate. Refer to the *AKD Installation Manual* for dimensions and additional information specific to the drive model.
2. Connect the protective earth (PE) to either ground screw on the drive grounding lug. Figure 2 shows the location of the grounding lug on the drive.

## Step 4: Connect the Logic Power Supply to the NI 9512 to AKD Drive Cable

The NI 9512 to AKD Drive Cable requires connection to an external +24 V power supply. The +24 V power supply provides both the logic power to the AKD servo drive and powers the NI 9512 module.



**Note** Do not plug in or turn on the +24 V power supply until after you complete [Step 8: Connect the Drive Communication](#).

Complete the following steps to connect the +24 V power supply to the cable.

1. Connect the +24 V power supply (+) terminal to the Vsup terminal on the NI 9512 to AKD Drive Cable screw terminal connector. Refer to Table 1 for the screw terminal connector pinout.
2. Connect the +24 V power supply return (–) terminal to the Vsup Return terminal on the NI 9512 to AKD Drive Cable screw terminal connector.

## Step 5: Connect the NI 9512 to AKD Drive Cable to the AKD Servo Drive

Connect the NI 9512 to AKD Drive Cable to the AKD servo drive. Refer to Figure 6 for the location of the connectors.

1. Connect the cable X1 3-pin connector to the AKD servo drive X1 3-pin connector. This connector provides +24 V power to both the drive logic and to the safe torque out (STO) input. The STO input must be powered by +24V for proper drive operation. If you need to use the STO functionality complete the following additional steps:
  - a. Disconnect the STO wire from the NI 9512 to AKD cable X1 connector and insulate it.

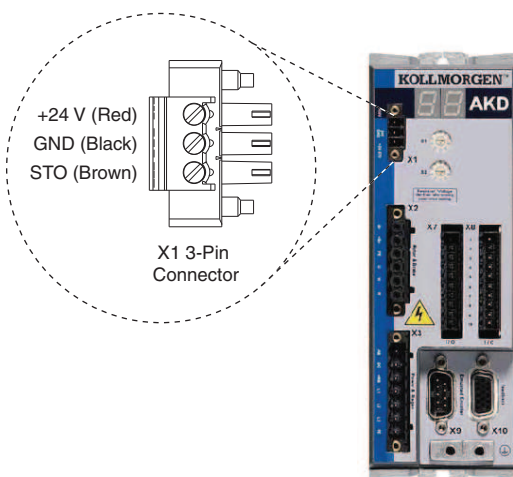


**Note** The STO and +24V wires are internally connected in the NI 9512 to AKD cable. You *must* insulate the STO wire if you disconnect it from the X1 connector.

- b. Connect the STO terminal and GND terminal to the output of a safety relay or security control. The safety relay must comply with the requirements of the SIL 2 according to IEC 61800-5-2, PL d according to ISO 13849-1, or Category 3 according to EN-954. Refer to the *AKD Installation Manual* for more information.

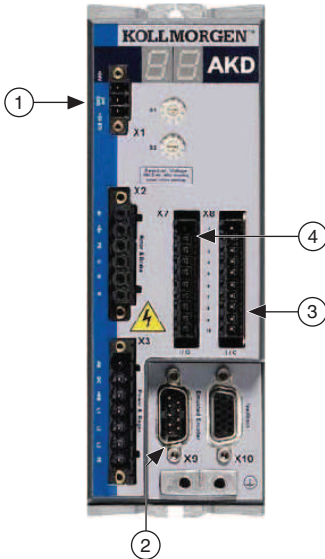
Figure 5 shows the X1 connector pin assignment and wire colors.

**Figure 5. AKD X1 Connector**



2. Connect the cable X9 DSUB connector to the AKD servo drive X9 DSUB connector.
3. Connect the cable X7 10-pin connector to the AKD servo drive X7 10-pin connector.
4. Connect the cable X8 10-pin connector to the AKD servo drive X8 10-pin connector.

**Figure 6. NI 9512 to AKD Drive Cable Connections**



1	+24 V Supply, STO (X1)	3	I/O (X8)
2	Encoder Emulation (X9)	4	I/O (X7)

## Step 6: Connect the Motor and Encoder to the Drive

All servo motors available from NI come pre-wired for direct connection to the AKD servo drive X2 motor connector and X10 feedback connector. Refer to Figure 7 for the location of the connectors.

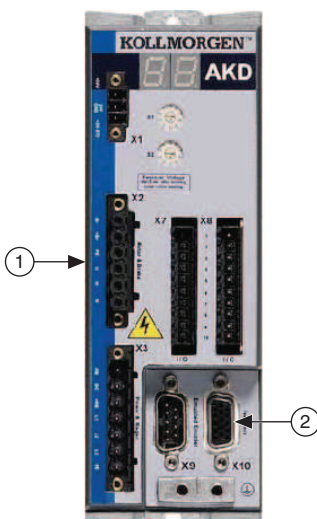
1. Connect the motor 6-pin connector to the AKD servo drive X2 motor connector.



**Note** The X2 connector also provides connection for the drive to control the +24 V holding brake for motors that have a brake. Refer to the *AKD Installation Manual* for information about using the holding brake.

2. Connect the motor DSUB feedback connector to the AKD servo drive X10 feedback connector.

**Figure 7. Motor and Encoder Connections**



1 Motor Connector (X2)

2 Feedback Connector (X10)

# Step 7: Connect the AC Input Power

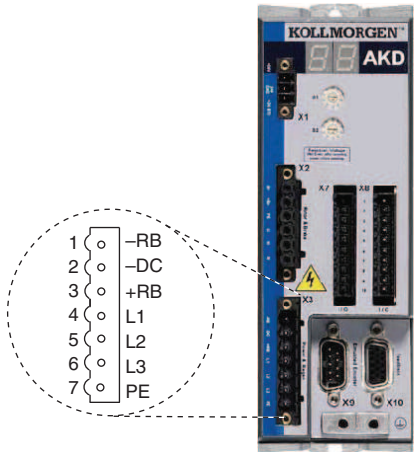
Connect the X3 mains supply connector to AC input power. Pins 4 through 7 contain the AC power signals. The X3 connector also provides signals for an external brake (regen) resistor ( $\pm$ RB) and DC bus link ( $-DC$ ). Refer to the *AKD Installation Manual* for information about using these terminals.



**Note** Do not turn on the AC power until after you complete [Step 8: Connect the Drive Communication](#).

Figure 8 shows the location and pin assignment for the X3 connector.

**Figure 8.** AKD Servo Drive X3 Connector



AC input power can be connected for either a three-phase or single-phase operation.



**Note** External filtering and fusing are optionally provided by the user. Refer to the *AKD Installation Manual* for information about filter and fuse requirements.

Figure 9 shows three-phase connection.

**Figure 9.** AC Input Power Three-Phase Connection

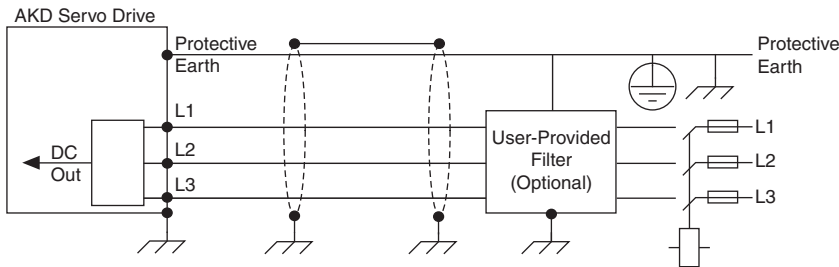
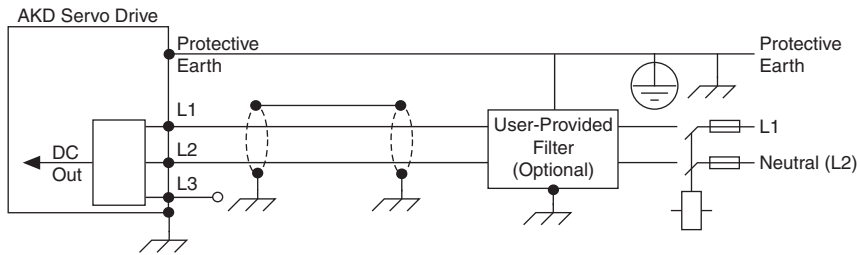


Figure 10 shows single-phase connection.

**Figure 10. AC Input Power Single-Phase Connection**

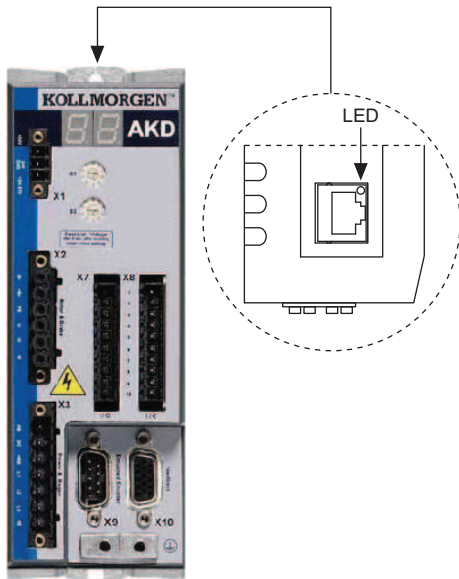


## Step 8: Connect the Drive Communication

Complete the following steps to set up the drive for software configuration using Ethernet. These steps assume you are connecting the AKD servo drive using a hub, switch, or router using DHCP. If you cannot use DHCP, refer to [Connecting to the PC Using a Static IP](#) in the [Tips and Troubleshooting](#) section for instructions about direct connection using a static IP address.

1. Set S1 and S2 on the drive to 0 to configure the drive for DHCP mode. The drive obtains an IP address from an external DHCP server if one exists on the network. If no DHCP server is present, the drive assumes an automatic private IP address in the form of 169.254.x.x. This process may take up to a minute to complete. Figure 2 shows the locations of S1 and S2.
2. Connect the AKD servo drive X11 service port to a hub, switch, or router using an Ethernet cable. Figure 11 shows the location of the X11 service port on the drive.

**Figure 11. AKD Servo Drive X11 Connector**



## Step 9: Confirm Drive Connections

After all hardware connections have been made complete the following steps to confirm the AKD hardware setup.

1. Apply AC power.
2. Turn on the +24 V power supply. After logic power is supplied to the drive, the drive displays the following sequence of flashes in the LED indicators. Figure 2 shows the location of the LED indicators on the AKD servo drive.
  - a. --
  - b. []
  - c. Drive IP address, flashed sequentially
  - d. Drive status, either current operation mode or the fault code if there is a fault condition. The operation modes are as follows:
    - o0—torque mode (current mode)
    - o1—velocity mode
    - o2—position mode



**Note** If the drive shows a fault code, click the **Clear Faults** button on the AKD WorkBench software toolbar after you install the AKD WorkBench software in [Step 5: Install AKD WorkBench and Configure the Drive](#) of the *Software Installation and Configuration* section and connect to the drive to clear the fault state. If the fault reappears, refer to the *AKD Fault and Warning Messages Card* that came with the drive for more information about the fault, including possible solutions. After resolving the cause of the fault, click the **Clear Faults** button on the toolbar again. Figure 17 shows the location of the **Clear Faults** toolbar button in the AKD WorkBench software.

## Software Installation and Configuration

---

This section covers installing and configuring the software for the AKD servo drive and NI 9512 C Series module.



**Note** If you are using an NI 9144 chassis, refer to [Software Installation and Configuration with the NI 9144](#) in the [Setting Up a Distributed System](#) section for alternate configuration instructions, then continue with [Step 2: Create a Project in Scan Interface Mode](#).


## Step 1: Install Software on and Configure the NI RT Controller

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 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 the system.



**Note** If you do not see the controller, you may need to disable the firewall on the development computer. Go to [ni.com/info](http://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.
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** pane in MAX and select **Format Disk**.
9. (Optional) Enable the **Keep Network Settings** checkbox if you want to retain the same target name and IP address.
10. Click **Format** to start formatting the disk.
11. When MAX finishes formatting the disk, set the **Safe Mode** switch to the **Off** position and click **OK**.
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 3.4.0 or later.
17. Click **Next**.
18. Select **LabVIEW NI SoftMotion Module** from the add-ons list.



**Note** If you are using the NI SoftMotion Module 2010 SP1 or earlier, also select **LabVIEW NI SoftMotion Module Scan Engine Support** from the list.

19. Click **Next** to install the selected software on the controller. Click **Help** if you need information about installing recommended software sets.
20. When the software installation completes, click **Finish** to reboot the controller.
21. Close MAX.

## Step 2: Create 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)* help file 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. Depending on which version of LabVIEW you are using the steps are slightly different.

### Creating a Project in LabVIEW 2012

1. Launch LabVIEW.
2. Select **File»Create Project** or **Project»Create Project** to display the **Create Project** dialog box. You can also click the **Create Project** button on the Getting Started window. The **Create Project** dialog box includes a list of templates and sample projects you can use to ensure that the project you create uses reliable designs and programming practices.
3. Select **Blank Project** from the list of templates.
4. Click **Finish**.
5. 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.

### Creating a Project in LabVIEW 2011 SP1 or Earlier

1. Launch LabVIEW.
2. Select **File»New Project** or **Project»New Project** to display the **Create Project** dialog box. You can also click the **Empty Project** link on the Getting Started 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.

## Step 3: Add Resources to the Project

1. 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.
2. Make sure that the **Existing target or device** radio button is selected.
3. Expand **Real-Time CompactRIO**.
4. Select the CompactRIO controller to add to the project and click **OK**.
5. 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.

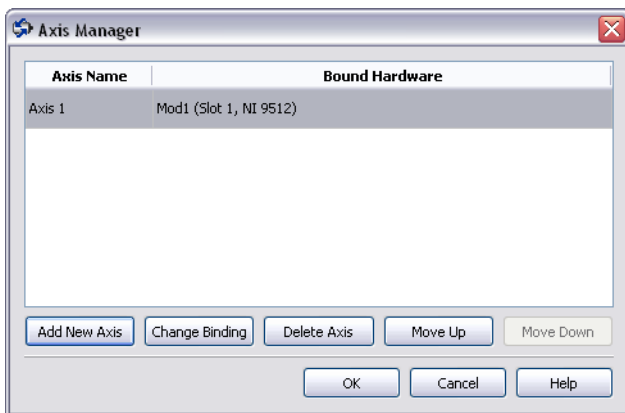
6. Click **Discover** in the **Discover C Series Modules?** dialog box if it appears.
7. Click **Continue**.



**Note** If you are using the NI 9144 chassis refer to [Adding the EtherCAT Master Device to the LabVIEW Project](#) in the [Setting Up a Distributed System](#) section for information about adding the EtherCAT master device before continuing.

8. Right-click the controller item in the **Project Explorer** window and select **Properties** from the shortcut menu to display the **RT Target Properties** dialog box. Select **Scan Engine** from the **Category** list to display the Scan Engine page.
9. Set the **Scan Period** to 5 ms or lower, then click **OK** to close the **RT Target Properties** dialog box.
10. Right-click the controller item 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 12.
11. Click **Add New Axis** to create an NI SoftMotion axis associated with the NI 9512 module. 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.

**Figure 12.** Axis Manager Dialog Box



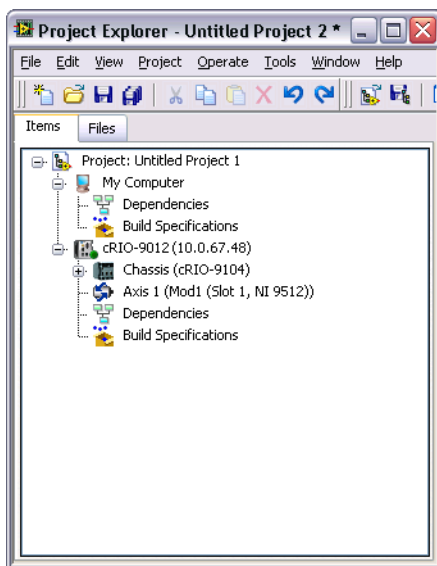
- Click **OK** to close the **Axis Manager** dialog box. The new axis is added to the **Project Explorer** window.



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

When you have finished these steps your LabVIEW project should look similar to the image in Figure 13.

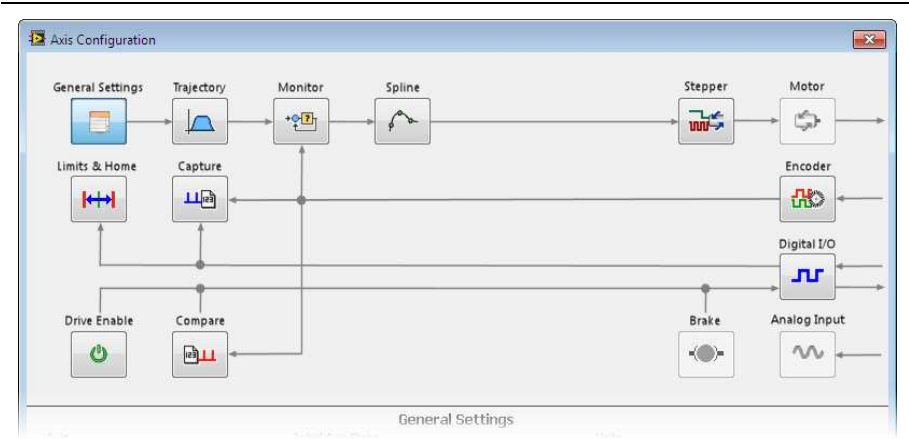
**Figure 13.** Project Explorer Window with Modules in Scan Interface Mode



# Step 4: Configure the NI 9512 Axis

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 9512 C Series module. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for detailed information about each configuration option.

**Figure 14.** Axis Configuration Dialog Box




**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.

Complete the following steps to configure the axis I/O settings for use with the AKD servo drive.

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. Configure the following settings on the **General Settings** page ( ).
  - a. 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.
  - b. Set **Feedback Source** to **Encoder 0**.
  - c. 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.


3. Click the Encoder button (  ) and configure the Units and Counts Per Unit.
  - a. In the **Active State** section set the **Line State** for **A**, **B**, and **Index** to **High**.
  - b. In the **Index Reference Criteria** section set the **Line State** for **A** and **B** to **Active**.
  - c. Select **rev** from the **Units** text box, or type **revolutions** if you prefer.
  - d. Set the **Counts per Unit** to 8,000. This setting is the encoder resolution in quadrature counts per revolution and must correspond to the AKD WorkBench emulated encoder output **Resolution** setting in lines per revolution multiplied by four. You may want to choose a different resolution depending on your application needs. A setting of 8,000 assumes an AKD WorkBench Emulated Encoder output **Resolution** setting of 2,000 lines per revolution.



**Note** You configure the emulated encoder output **Resolution** setting in [Step 5: Install AKD WorkBench and Configure the Drive](#) in the [Software Installation and Configuration](#) section.



When you are finished the Encoder Settings page will look similar to Figure 15.




**Figure 15. Axis Configuration Encoder Page**

4. Click the Stepper button (  ) to open the **Stepper** page.
  - a. Ensure that the Stepper Output settings match the following:
    - **Output Mode**—Step/Direction
    - **Output Type**—Single-Ended
    - **Active State**—Active Low
  - b. Configure the Units and Steps Per Unit.
    - Select **rev** from the **Units** text box, or type **revolutions** if you prefer.
    - Set **Steps Per revolution** to 8,000.



**Note** The **Steps Per revolution** setting *must* match the AKD WorkBench **Feedback 2 Resolution** parameter specified in [Step 5: Install AKD WorkBench and Configure the Drive](#).

- c. (Optional) Click the **Monitor** button (  ) and enable the **Enforce Position Error Limit** checkbox. This causes NI SoftMotion to disable the drive and turn off the Drive Enable signal when the specified position error limit is exceeded.
5. (Optional) Click the **Digital I/O** button (  ) to open the **Digital I/O** page and map the following optional status inputs.
  - a. Complete the following steps to map DI 1 (DSUB Pin 8) to **Drive Fault/Alarm**. When the **Drive Fault/Alarm** signal is active, the module does not generate command signals.
    - 1) Double-click the text in the **Mapping** column and select **Drive Fault/Alarm** from the dropdown list.
    - 2) Ensure that the DI 1 settings match the following:
      - **Input Type**—Sinking
      - **Active State**—Off
      - **Digital Filter**—50  $\mu$ s
  - b. Complete the following steps to map DI 2 (DSUB Pin 4) to **Servo/Drive Ready**. This signal is active when the drive is enabled.
    - 1) Double-click the text in the **Mapping** column and select **Servo/Drive Ready** from the dropdown list.
    - 2) Ensure that the DI 2 settings match the following:
      - **Input Type**—Sourcing
      - **Active State**—On
      - **Digital Filter**—50  $\mu$ s
  - c. Complete the following steps to map DI 3 (DSUB Pin 3) to **In-Position**. The **In-Position** signal from the AKD servo drive is active when the current position is within a user-specified distance from the target position. This distance is set in [Step 5: Install AKD WorkBench and Configure the Drive](#) when the **Position Error Monitor** output is configured.
    - 1) Double-click the text in the **Mapping** column and select **In-Position** from the dropdown list.
    - 2) Ensure that the DI 3 settings match the following:
      - **Input Type**—Sourcing
      - **Active State**—On
      - **Digital Filter**—50  $\mu$ s

6. (Optional) Click the **Trajectory** button (  ) and enable the In-Position to be used as a criteria for move complete. When this signal is included in the move complete criteria, the move is only complete if the In-Position signal is active.
7. Click the **Drive Enable** button (  ) and ensure that the Drive Enable settings match the following:
  - **Output Type**—Sourcing
  - **Active State**—On
  - **Safe State**—Off
8. Complete the following additional steps if you do not have limits and home connected at this time:
  - a. Click the **Limits & Home** button (  ).
  - b. In the **Forward Limit** and **Reverse Limit** sections ensure that the settings match the following:



**Note** These configuration settings disable limits for initial setup and testing purposes. National Instruments recommends connecting and enabling limits in your final application.

- Clear the **Enable** checkbox from both **Forward Limit** and **Reverse Limit**.
  - Set the **Active State** for both **Forward Limit** and **Reverse Limit** to **Off**. This prevents a limit warning even though limits are turned off.
- c. Open the **Home** section and clear the **Enable** checkbox.
9. Configure any additional I/O settings according to your system requirements, such as position compare or position capture signals.
  10. Click **OK** to close the **Axis Configuration** dialog box.
  11. Right-click the controller item in the **Project Explorer** window and select **Deploy All** to deploy the axis information.
  12. Select **File»Save Project** to save the project.




# Step 5: Install AKD WorkBench and Configure the Drive

AKD WorkBench is available on the CD that came with the AKD servo drive and is also available from [ni.com/updates](http://ni.com/updates). Complete the following steps to install AKD WorkBench.

- 1. Insert the AKD WorkBench CD in the CD-ROM drive.
- 2. Double-click `Full Setup.exe` to launch the installer.
- 3. Follow the onscreen instructions to complete the installation.

Complete the following steps to configure the drive settings with AKD WorkBench.

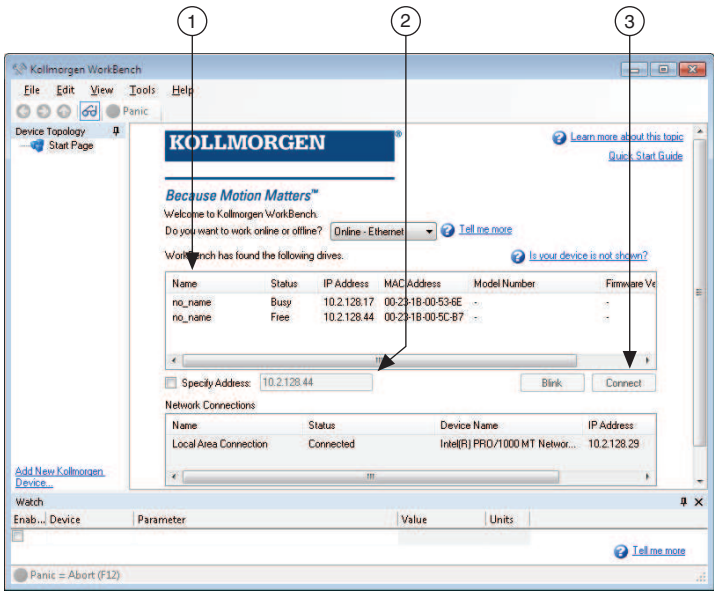
- 1. Launch the AKD WorkBench software by clicking the AKD WorkBench icon on the desktop (  ), or by selecting **Start»All Programs»Kollmorgen»AKD WorkBench**.
- 2. Select the drive to configure from the list and click **Connect**.



**Note** If the drive is not in the list, refer to the [Tips and Troubleshooting](#) section of this document for possible solutions.

Figure 16 shows the AKD WorkBench **Start** page.

**Figure 16.** AKD WorkBench Start Page



1 Available Drives

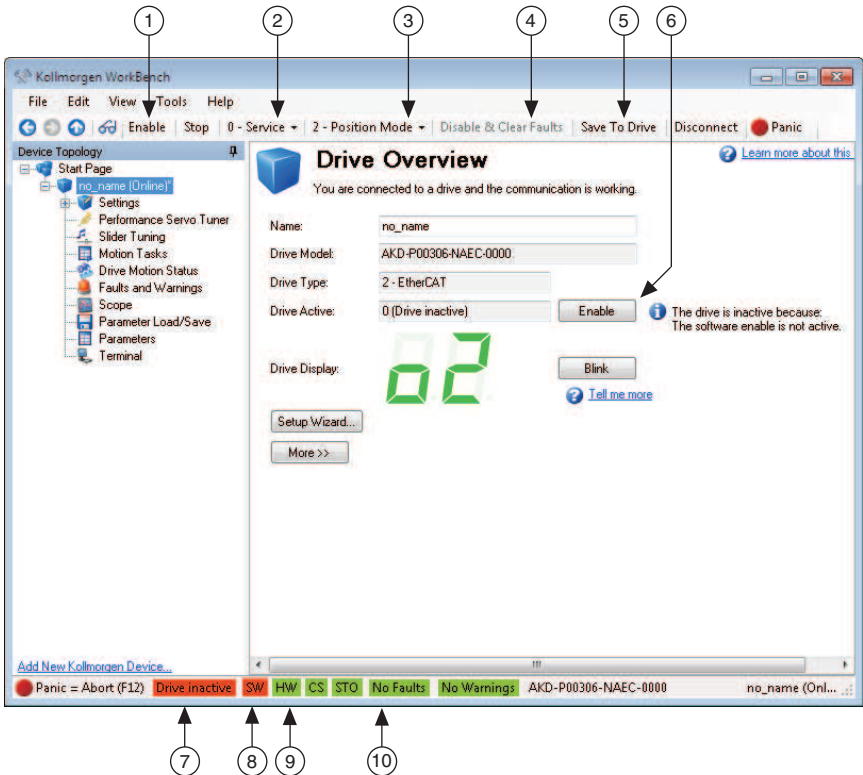
2 Specify Address

3 Connect to Drive

- Open the **Parameter Load/Save** page from the configuration tree and click **Factory Defaults** to return the drive settings to the factory default values. Any drive settings not updated in this document are assumed to be the default values.
- (Optional) Change the name of the drive from the default name of `no_name` on the **AKD Overview** page to a more descriptive name.

Figure 17 shows the **AKD Overview** page.

**Figure 17. AKD WorkBench Overview Page**



- |  |                                    |
|--|------------------------------------|
| 1 Software Enable/Disable              | 6 Software Enable/Disable          |
| 2 Command Source                       | 7 Drive Active Indicator           |
| 3 Operation Mode                       | 8 Software Enable Status Indicator |
| 4 Clear Faults                         | 9 Hardware Enable Status Indicator |
| 5 Save Configuration Settings to Drive | 10 Fault Indicator                 |

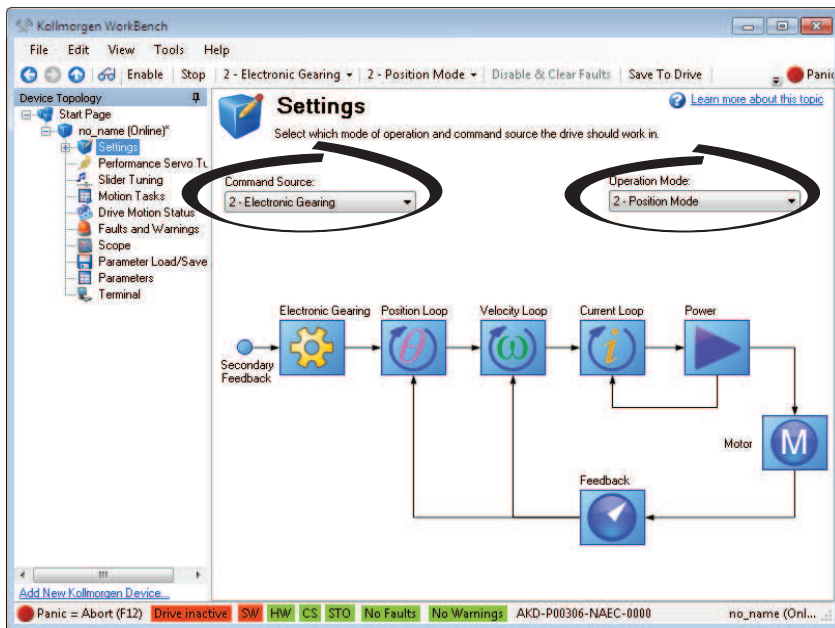
5. Configure the command source and operation mode.
  - a. Open the **Settings** page and set the **Operation Mode** to **2 - Position Mode**.
  - b. Set the **Command Source** to **2 - Electronic Gearing**.



**Note** You must set the **Operation Mode** before setting the **Command Source** or AKD WorkBench returns an error.

When you have updated these settings, the **Settings** page should look similar to Figure 18.

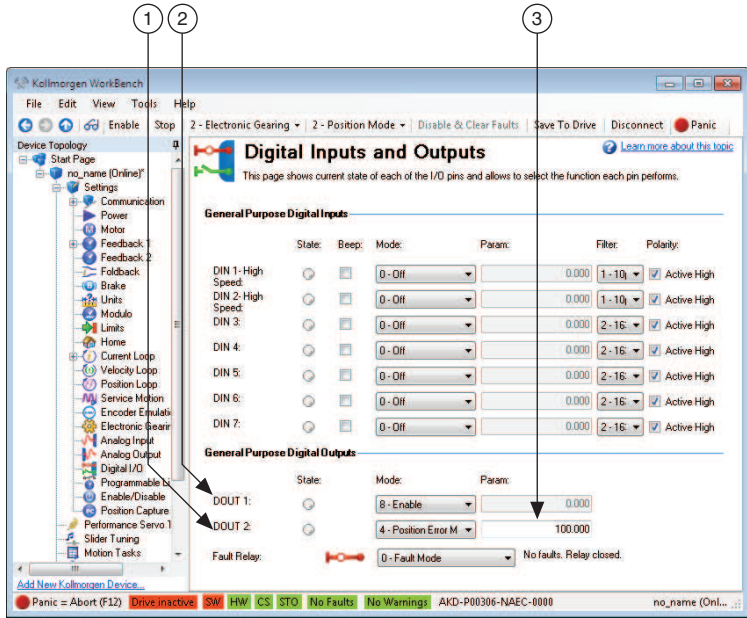
**Figure 18.** AKD WorkBench Settings Page



6. If you mapped any digital input in [Step 4: Configure the NI 9512 Axis](#), configure the AKD servo drive digital outputs for the same signals:
  - a. Open the **Digital I/O** page under the **Settings** tree item.
  - b. If you mapped the NI 9512 DI 2 signal to **Servo/Drive Ready**, select **8 - Enable** from the DOUT 1 **Mode** list.
  - c. If you mapped the NI 9512 DI 3 signal to **In-Position**, select **4 - Position Error Monitor** from the DOUT 2 **Mode** list.
  - d. Set **Param** for the Position Error Monitor output to a reasonable tolerance for the system resolution. This setting will depend on the specified encoder counts and steps per revolution setting.

When you are finished configuring the digital outputs, the **Digital Inputs and Outputs** page will look similar to Figure 19.

**Figure 19. AKD WorkBench Digital Inputs and Outputs Page**



1 DOUT 2 Configuration      2 DOUT 1 Configuration      3 DOUT 2 Param Setting

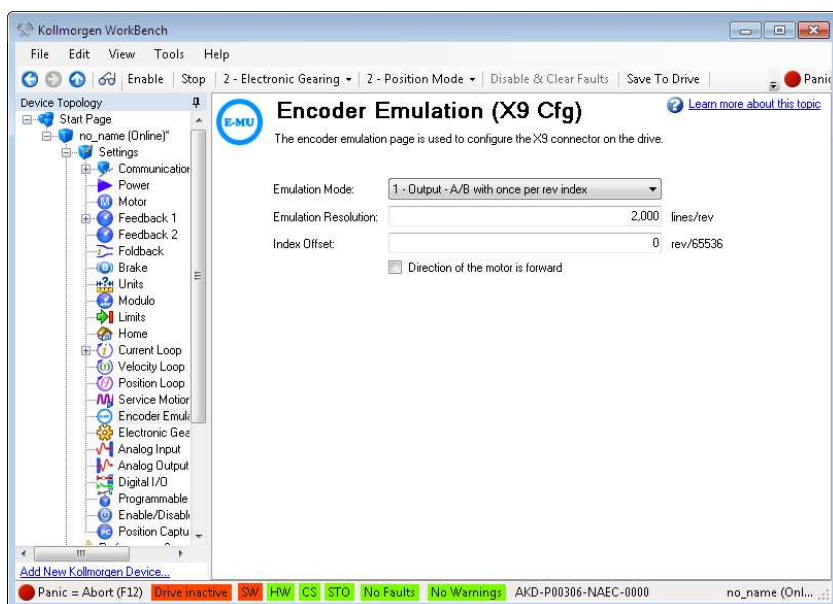
7. Configure the emulated encoder output.
  - a. Expand the **Settings** tree item and open the **Encoder Emulation** page.
  - b. Select **1 - Output - With once per rev index pulse** from the **Function** dropdown list.
  - c. Set the **Resolution** to 2,000 lines/rev.



**Note** The encoder resolution output value determines the equivalent resolution of an incremental encoder in pulses per revolution (PPR). NI SoftMotion returns encoder positions in encoder counts per revolution. A resolution of 2,000 lines/rev is the same as 8,000 quadrature counts per revolution. You may want to choose a different value depending on your application needs. In general, higher resolution values result in more difficult servo loop tuning; lower resolution values provide less accuracy.

Figure 20 shows the AKD WorkBench **Encoder Emulation** page.

**Figure 20.** AKD WorkBench Encoder Emulation Page



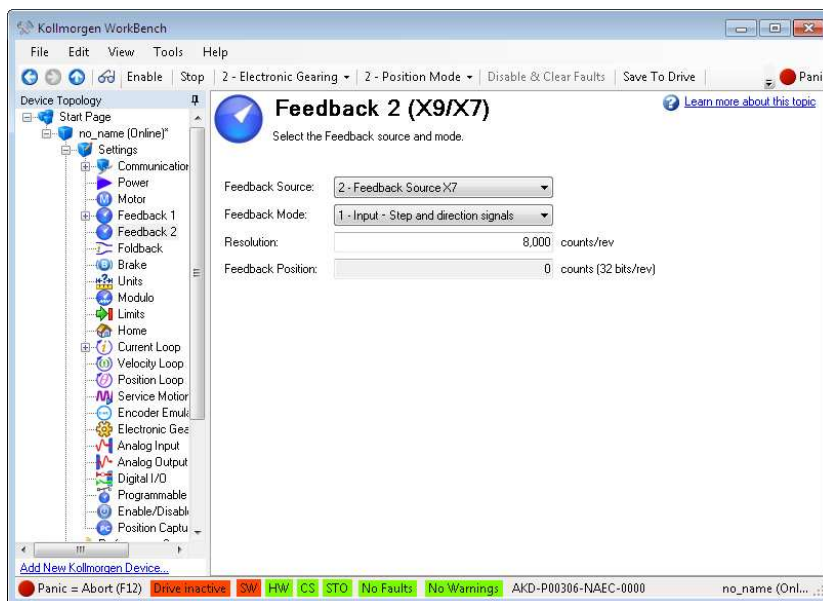
8. Configure the secondary feedback resolution. This is the NI 9512 steps per revolution, and must match the **Steps Per revolution** setting specified in [Step 4: Configure the NI 9512 Axis](#).
  - a. Open the **Feedback 2** page under the **Settings** tree item.
  - b. Set the **Feedback Source** to **2 - Feedback Source X7**.
  - c. Confirm that the **Feedback Mode** is **1 - Input - Step and direction signals**.
  - d. Set the **Resolution** to 8,000. A setting of 8,000 counts/rev corresponds to 1 step per count, when the AKD emulated encoder **Resolution** is set to 2,000 and the NI SoftMotion encoder **Counts Per revolution** is set to 8,000.



**Note** Depending on your application needs, you can chose a value other than 8,000. However, the **Feedback 2 Resolution** setting *must* match the NI SoftMotion Module **Steps Per revolution** setting specified in [Step 4: Configure the NI 9512 Axis](#).

Figure 21 shows the AKD WorkBench **Feedback 2** page.

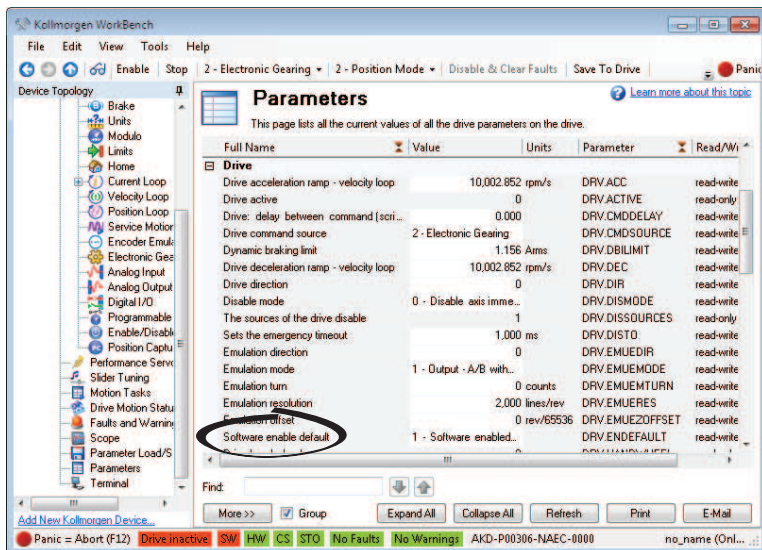
**Figure 21.** AKD WorkBench Feedback 2 Page



9. Configure the software enable signal:
  - a. Click the **Parameters** tree icon to list all configurable drive parameters.
  - b. Expand the **Drive** section.
  - c. Set the **Software enable default** parameter to 1. This enables the drive on bootup so you do not have to enable the drive from WorkBench.

Figure 22 shows the AKD WorkBench **Parameters** page.

**Figure 22.** AKD WorkBench Parameters Page



10. Activate the software enable on the drive by clicking the **Enable** button on the **AKD Overview** page or on the toolbar. Figure 17 shows the location of the **Enable** button.
11. Save all configuration changes to the drive by clicking the **Save to Drive** toolbar button shown in Figure 17.

## Step 6: Tune the Motor Using the WorkBench Performance Servo Tuner

Use the AKD WorkBench Performance Servo Tuner to quickly tune the servo motor with a single click. Tune the system with a load connected for best results.

1. Select **Performance Servo Tuner** under the drive tree item.
2. Confirm that the drive is hardware enabled and enable it if it is not.
3. Click **Start**. The Performance Servo Tuner performs a series of tests and displays the results on the page. The progress bar shows the relative progress of the tuning process.
4. When tuning is complete, the **Complete** LED illuminates and the Performance Servo Tuner page displays a Bode plot showing the frequency response of the system.



**Note** Refer to the *Using the Performance Servo Tuner* topic in the *WorkBench Help* for more information about using the autotuner including advanced autotuning options.

## Step 7: Enable and Test the Drive Using LabVIEW



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 feedback position and position error information, move and I/O status information, change move constraints, get information about software errors and faults, and view position or velocity plots of the move.

Complete the following steps to test your setup after configuring the axis using the **Axis Configuration** dialog box and configuring the drive with the AKD WorkBench software.

1. Right-click the axis in the **Project Explorer** window and select **Interactive Test Panel** from the shortcut menu. Opening this dialog box sends the axis settings to the hardware and activates the I/O on the module.
2. On the **Move** tab set **Target Position** to 25 revolutions.
3. On the **Move Constraints** tab set **Velocity** to 1 revolution/sec. Using the encoder counts per revolution and stepper steps per revolution values specified in this tutorial the motor will move 25 revolutions at 60 RPM.



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

4. Click the **Enable** button (  ) on the bottom of the dialog box to enable the drive.
5. Click the **Start** button (  ) on the bottom of the dialog box to start the move with the configured options.
6. Use the **Status** and **Plots** tabs to monitor the move while it is in progress.  
Finalize your motion system setup by connecting and configuring additional I/O such as limits as required by your system using the 20-pin screw terminal connector. Table 1 shows the screw-terminal connector pinout.

## Setting Up a Distributed System

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### 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.

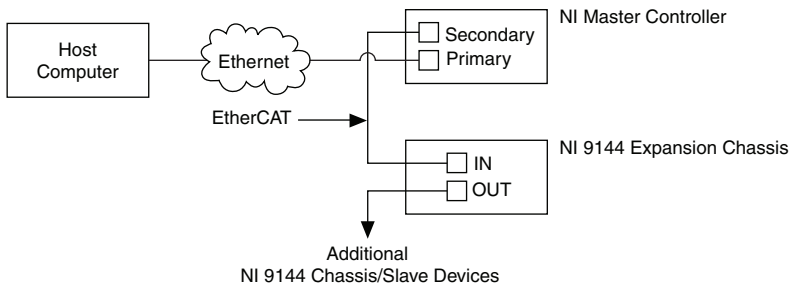




**Note** Do not plug in or turn on any power to the system until after you complete *Step 8: Connect the Drive Communication*.

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 23.** Connecting the NI 9144 Chassis to Network



4. Install the NI 9512 module in slot 1, 2, 3, or 4 of the NI 9144 chassis.
5. If using the NI 9144 chassis with a PXI master controller, disable **Legacy USB Support** in the host PC BIOS, if it is enabled.
6. Continue with *Step 2: Connect NI 9512 to AKD Drive Cable to the C Series Module*.

## 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. Expand the **Remote Systems** tree.
3. Select the controller under **Remote Systems** in the **Configuration** pane.



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

4. Verify that the **Serial Number** in the **Identification** 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, power on the controller and skip to step 15.

6. Set the **Safe Mode** switch on the controller to the **On** position.
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** pane and select **Format Disk**. Click **Yes** on the dialog box that appears.
9. 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.
10. Select the **System Settings** tab and type a descriptive name for the system in the **Name** field.
11. (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.
12. Click **Save** on the toolbar and let MAX reboot the system.
13. When the new system name appears under **Remote Systems**, expand the controller item in the tree, right-click **Software**, and select **Add/Remove Software**.
14. Select a recommended software set that includes NI-RIO 3.4.0 or later.
15. Click **Next**.
16. Select the following items from the add-ons list.
  - LabVIEW NI SoftMotion Module
  - IndCom for EtherCAT Scan Engine Support



**Note** If you are using the NI SoftMotion Module 2010 SP1 or earlier, also select **LabVIEW NI SoftMotion Module Scan Engine Support** from the list.

17. Click **Next** to install the selected software on the controller. Click **Help** if you need information about installing recommended software sets.
18. When MAX finishes installing the software on the controller, select the controller under **Remote Systems** in the **Configuration** pane.
19. Click the **Network Settings** tab and expand **More Settings** in the **eth1** section
20. Select **EtherCAT** from the **Adapter Mode** list.



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

21. 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 24.

**Figure 24.** Network Settings Tab

The screenshot displays the 'Network Settings' window. The top section is for 'eth0 (Primary)'. It shows the MAC Address as 00:80:2f:11:80:c9. The 'Configure IPv4 Address' dropdown is set to 'DHCP or Link Local'. Below this, the IPv4 Address is 10.0.67.106, Subnet Mask is 255.255.255.0, Gateway is 10.0.67.1, and DNS Server is 130.164.12.30. A blue arrow icon and the text 'Fewer Settings' are visible. The bottom section for 'eth0' shows 'Adapter Mode' set to 'TCP/IP Network', 'Preferred Link Speed' set to 'Autonegotiate', 'Packet Detection' set to 'Polling', and 'Polling Interval' set to 1 (with a range of 1 - 10000). A 'Make Primary' button is at the bottom right. The bottom section is for 'eth1', showing 'EtherCAT Master ID' set to 0 (with a range of 0-255). A blue arrow icon and the text 'Fewer Settings' are visible. The bottom section for 'eth1' shows 'Adapter Mode' set to 'EtherCAT'. A 'Make Primary' button is at the bottom right.

22. Click **Save**.
23. Close MAX.
24. Continue with [Step 2: Create a Project in Scan Interface Mode](#).

## 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 25, 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 25.** 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.

## Tips and Troubleshooting

### The Drive Does Not Enable

If, after going through all steps in this document, the AKD servo drive does not enable, verify the following settings:

- The Drive Enable line from the NI 9512 C Series module must be active. Figure 17 shows the location of the hardware enable indicator in the AKD WorkBench software.
- The software enable must be enabled. This setting is available on the upper toolbar in the AKD WorkBench software. Figure 17 shows the location of the software enable indicator and toolbar button.
- The drive must not be in a fault state. Click the **Clear Faults** button on the WorkBench toolbar to clear the fault state after determining and fixing the source of the fault. Figure 17 shows the location of the Fault indicator and **Clear Faults** toolbar button.



**Tip** Refer to the *AKD Fault and Warning Messages* card that came with the drive for fault information and solutions.

### Cannot Communicate with the Drive Using Ethernet

Confirm that the link LEDs on the drive and PC are both illuminated. Figure 11 shows the location of the link LED on the drive.

# Increasing the Maximum Velocity and Acceleration

The default AKD settings limit the velocity to 3000 RPM and the acceleration and deceleration to 10,000 RPM/sec. These limits are acceptable for most applications. Complete the following steps to modify the limits if your application requires different limits.

1. Launch the AKD WorkBench software.
2. Select the drive to configure from the list and click **Connect**.
3. Open the **Electronic Gearing** page under the **Settings** tree item.
4. Set **Maximum Velocity** to 8000 RPM and set both **Maximum Acceleration** and **Maximum Deceleration** to 200,000 RPM/sec.
5. Save the configuration changes to the drive by clicking the **Save to Drive** toolbar button shown in Figure 17.

## Connecting to the PC Using a Static IP

1. Use the S1 and S2 rotary switches on the drive to set a static IP address. The IP address is 192.168.0.S1S2. For example, if S1 is set to 2 and S2 is set to 3 the IP address is 192.168.0.23.



**Note** If you change S1 or S2 when the +24 V power supply is powered on, you must unplug the network cable from the drive for at least three seconds to reset the IP address.

2. Connect the AKD servo drive to the computer directly using an Ethernet cable. Figure 11 shows the location of the X11 service port on the drive.
3. Complete the following steps to configure the static IP based on your operating system version.

### Windows XP

- a. Select **Start»Control Panel»Network Connections** to open the **Network Connections** dialog box.
- b. Select the network connection type corresponding to the port you used to connect the AKD servo drive. This will most likely be **Local Area Connection x**, where x corresponds to the number of the connection.
- c. Click **Properties** to open the **Local Area Connection Properties** dialog box.
- d. Select **Internet Protocol (TCP/IP)** from the list and click **Properties**.
- e. In the **Internet Protocol (TCP/IP)** dialog box, select **Use the following IP address**.
- f. Change **IP address** to 198.168.0.100.
- g. Change **Subnet mask** to 255.255.255.0.

### Windows Vista or Later

- a. Select **Start»Control Panel»Network and Sharing Center**.
- b. Select the network connection type corresponding to the port you used to connect the AKD servo drive. This will most likely be **Local Area Connection x**, where x corresponds to the number of the connection.

- c. Click **Properties** to open the **Local Area Connection Properties** dialog box.
- d. Select **Internet Protocol Version 4 (TCP/IPv4)** from the list and click **Properties**.
- e. In the **Internet Protocol Version 4 (TCP/IPv4)** dialog box, select **Use the following IP address**.
- f. Change **IP address** to 198.168.0.100.
- g. Change **Subnet mask** to 255.255.255.0.

Verify that S1 and S2 are set to non-zero values.

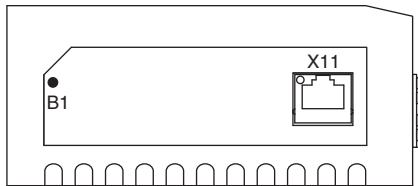
## The Motor Responds Poorly

Use the AKD WorkBench Autotuner to change the control loop settings for the motor. Refer to the *Using the Autotuner* topic in the *WorkBench Help* for more information about using the autotuner including advanced autotuning options.

## Cannot See the AKD Servo Drive in the AKD WorkBench Software

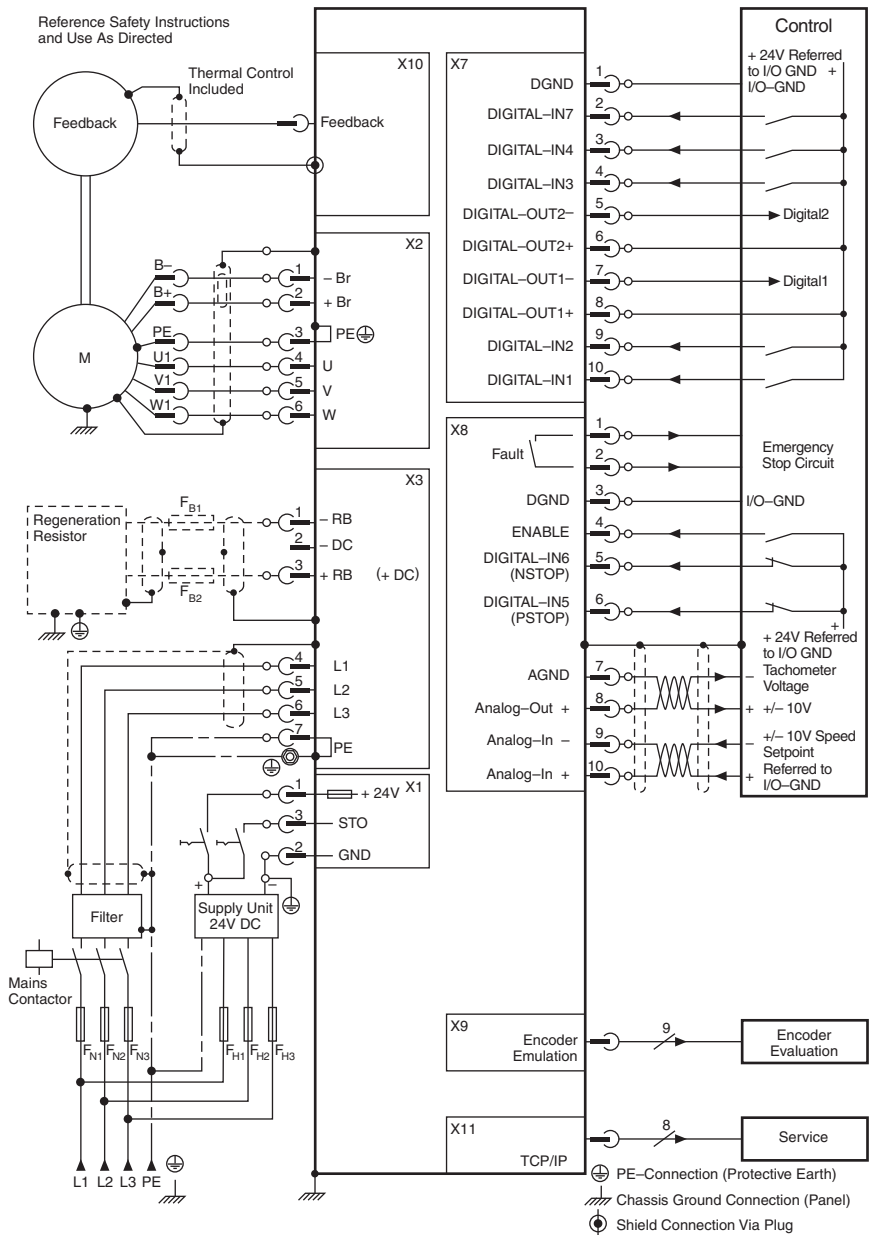
Manually enter the drive IP address by enabling the **Specify Address** checkbox on the AKD WorkBench software Start Page shown in Figure 16. To obtain the drive IP address either press the B1 button on the top of the drive or disconnect and reconnect the Ethernet cable. In either case, the LED displays the digits and dots of the IP address in sequence. Figure 26 shows the location of the B1 button.

**Figure 26.** AKD Servo Drive B1 Button



# Wiring Diagram

**Figure 27. AKD Wiring Diagram**



# Worldwide Support and Services

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The National Instruments Web site is your complete resource for technical support. At [ni.com/support](http://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.

Visit [ni.com/services](http://ni.com/services) for NI Factory Installation Services, repairs, extended warranty, calibration, and other services.

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