

# Getting Started with NI SoftMotion™ for SolidWorks

This tutorial demonstrates how to set up and design motion simulations using NI SoftMotion for SolidWorks. You will use the LabVIEW Project to connect to a preconfigured SolidWorks motion study, create and configure NI SoftMotion axes for the motors in the SolidWorks assembly, and use NI SoftMotion function blocks to create a trajectory for the SolidWorks simulation.



**Note** This document covers how to use NI SoftMotion function blocks with your existing SolidWorks assemblies to create and evaluate motion profiles for your system. For information about using SolidWorks refer to the SolidWorks documentation.

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# Required Components

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This section lists the software used in the tutorial. 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 (32-bit) or later
- LabVIEW NI SoftMotion Module Standard 2009 or later
- NI SoftMotion for SolidWorks



**Note** NI SoftMotion for SolidWorks requires free activation. Refer to the *Working With SolidWorks Assemblies* topic in the *NI SoftMotion Module* book of the *LabVIEW Help* for information about activating this feature.

- SolidWorks 2009 Service Pack 2.1 or higher and SolidWorks Motion Simulation with the Motion Simulation add-in enabled from the **Tools** menu in SolidWorks. This is included with SolidWorks Premium, Simulation Premium, or Simulation Professional.



**Tip** When you enable the Motion Simulation add-in from the **Add-Ins** dialog box in SolidWorks, place a checkmark in both the left and right checkboxes so you do not have to re-enable the add-in each time you use NI SoftMotion for SolidWorks.

You can download a free 30-day trial of the required National Instruments software from [ni.com/labview/family](http://ni.com/labview/family).

## Optional Hardware and Software

The following additional hardware and software is required to complete the [Step 4: Deploying to Hardware \(Optional\)](#) section of this tutorial:

- Software
  - LabVIEW Real-Time Module 2009 or later
  - NI-RIO 3.2.0 or later
- Hardware
  - CompactRIO controller and chassis that support the RIO Scan Interface
  - or
  - NI 9144 distributed chassis

- Two NI 9512 single-axis stepper drive interface modules
- Power supply for the controller
- A separate power supply for the modules
- Ethernet connection and cable



**Tip** Even if you do not have the hardware used in this tutorial, you can follow the steps and perform offline configuration to learn concepts about using CompactRIO with LabVIEW.

## Related Documentation

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

- *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»Search the 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**.
- *LabVIEW NI SoftMotion Module Help*—Use this help file to learn about using NI SoftMotion in LabVIEW including information about function blocks and using NI SoftMotion with the LabVIEW Project. To access this help file from LabVIEW, select **Help»Search the LabVIEW Help**, then expand the *NI SoftMotion Module* book on the **Contents** tab.
- *SolidWorks Help*



**Note** Refer to the software documentation for installation information.

# Overview of NI SoftMotion for SolidWorks

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Using NI SoftMotion with SolidWorks to simulate your system with actual motion profiles allows you to simulate mechanical dynamics, including mass and friction effects, cycle times, and individual component performance before specifying a single physical part and connecting it to an actual control algorithm. Digital prototyping offers the ability to visualize and optimize the design and evaluate different design concepts before incurring the cost of physical prototypes.

Integrating motion simulation with CAD simplifies design because the simulation uses information that already exists in the CAD model, such as assembly mates, couplings, and material mass properties. LabVIEW provides an easy to use, high-level function block programming language for programming the motion control system that is easy enough for users with little or no previous motion control programming experience.

Typical applications for the LabVIEW NI SoftMotion Module with NI SoftMotion for SolidWorks include the following:

- **Motion trajectory design**—You can build complex motion profiles containing a series of sequential or concurrent move operations composed of multi-axis straight-line moves, contoured moves, arc moves, and even complex moves using electronic gearing and camming.
- **Visualization**—By animating your 3D SolidWorks assembly using the motion control profiles and timing/sequencing logic you have designed in LabVIEW, you can quickly evaluate the feasibility of the overall conceptual design for your machine.

Visualizing the working machine as a virtual prototype helps to validate the overall conceptual design for the machine very early in the development. This fosters better communication with customers and between design team members and helps to close the loop on the design requirements, must-have features, and engineering trade-offs.

- **Collision detection**—The collision detection feature in SolidWorks enables you to validate your motion profile designs using your actual 3D CAD model. You can check for interferences, evaluate the need for interlock control logic to prevent collisions, optimize your motion profiles to minimize unnecessary dead time, quickly evaluate what-if scenarios, and safely test new control system logic without the risk of damaging your physical machine. After your machine has been designed, prototyped and deployed to the field, collision detection can also be used to validate new motion profiles before downloading them to machines operating at your customer site; reducing the risk of unplanned downtime due to programming mistakes.

- **Throughput time studies**—By validating your motion system design using a simulation that includes the actual motion profile constraints and the mechanical dynamics of your machine such as mass and friction, you can accurately calculate an estimate for the cycle time throughput of your machine.
- **Motor, drive, and transmission sizing**—Motor torque and velocity requirements depend on the acceleration characteristics of your motion profile and the mechanical dynamics of the payload and transmission components such as lead screws. Using NI SoftMotion, you can calculate the required motor torque and velocity charts for your motion profiles.

## Step 1: Setting Up the LabVIEW Project

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Before you can start designing motion profiles for your SolidWorks simulation, you need to import the information from your SolidWorks assembly into the LabVIEW Project and create NI SoftMotion axes for the simulated motors included in your assembly.



**Tip** Refer to the *Working with SolidWorks Assemblies* topic in the *NI SoftMotion Module* book of the *LabVIEW Help* for a list of caveats and recommendations to consider when creating and using SolidWorks assemblies with the NI SoftMotion Module.

### Adding the SolidWorks Assembly to the Project

Complete the following steps to add the SolidWorks assembly to the LabVIEW Project:

1. Launch SolidWorks and open the `Sorting Machine.SLDASM` file from the `<labview>\examples\motion\SoftMotion\SolidWorks CoSimulation\Sorting Machine (SolidWorks Files)` directory. This model simulates an assembly that takes test tubes from one location and moves them to another.

This tutorial focuses on using an arc move to move the test tubes to a rotary table. At this point, the assembly and motion study must be ready to simulate with all the constraints and motors properly configured. Refer to the *SolidWorks Help* for more information about setting up a SolidWorks assembly.



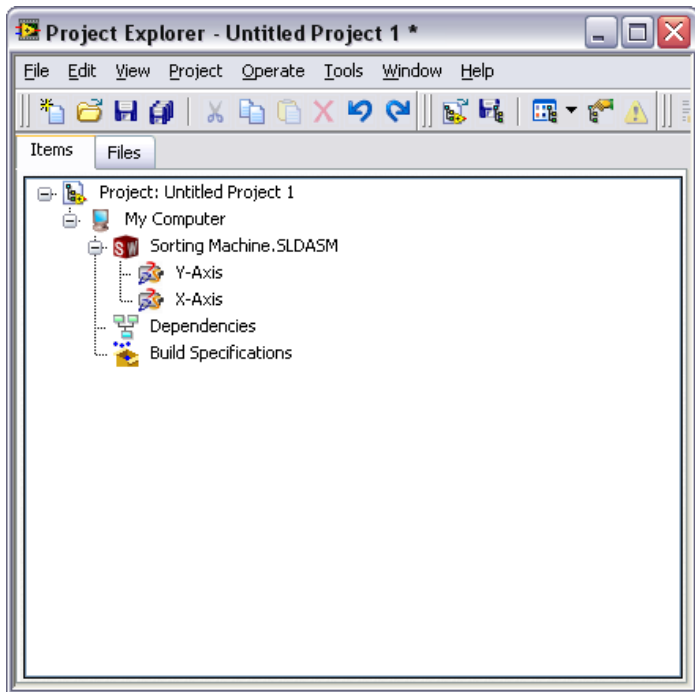
**Tip** Use the NI Example Finder, available in LabVIEW at **Help»Find Examples** to find additional examples using NI SoftMotion for SolidWorks.

2. Right-click **My Computer** in the **Project Explorer** window and select **New»SolidWorks Assembly** from the shortcut menu to open the **Import Axes from Assembly File** dialog box.
3. Select the SolidWorks assembly to add to the LabVIEW project. If a SolidWorks assembly is currently open, the **Import Axes from Assembly File** dialog box contains the path of this assembly. Click **Browse** to select a different assembly file if necessary.
4. Click **OK**. The selected SolidWorks assembly is added to the **Project Explorer** window, including all motors contained in the SolidWorks motion study.



**Note** If the SolidWorks assembly contains multiple motion studies, choose the motion study to add to the project using the **Select Motion Study** dialog box. To change the motion study used in the project after adding the assembly, right-click the SolidWorks assembly item in the project tree and select **Change Motion Study** from the shortcut menu.

The following figure shows the **Project Explorer** window with a SolidWorks assembly added.



**Figure 1.** SolidWorks Assembly in the LabVIEW Project

5. Right-click the SolidWorks assembly in the **Project Explorer** window and select **Properties** from the shortcut menu to open the **Assembly Properties** dialog box. In the **Data Logging Properties** section, specify a name for the log file and place a checkmark in the **Log Data** checkbox. This will log position, velocity, acceleration, and torque data for the simulation to the specified file name in LabVIEW Measurement (.lvnm) format.

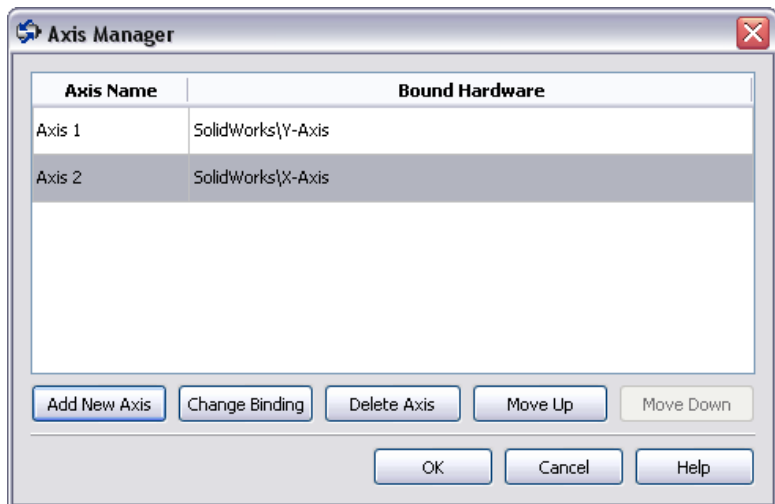


**Note** Each simulation overwrites the selected log file. To create a new log file for the next simulation you must change the file name before starting the simulation.

## Adding Axes to the Project

To simulate using the SolidWorks motors included in the model, you need to associate the motors with NI SoftMotion axes. The NI SoftMotion axes are used when creating motion profiles using the NI SoftMotion function blocks. Complete the following steps to add NI SoftMotion axes to the project:

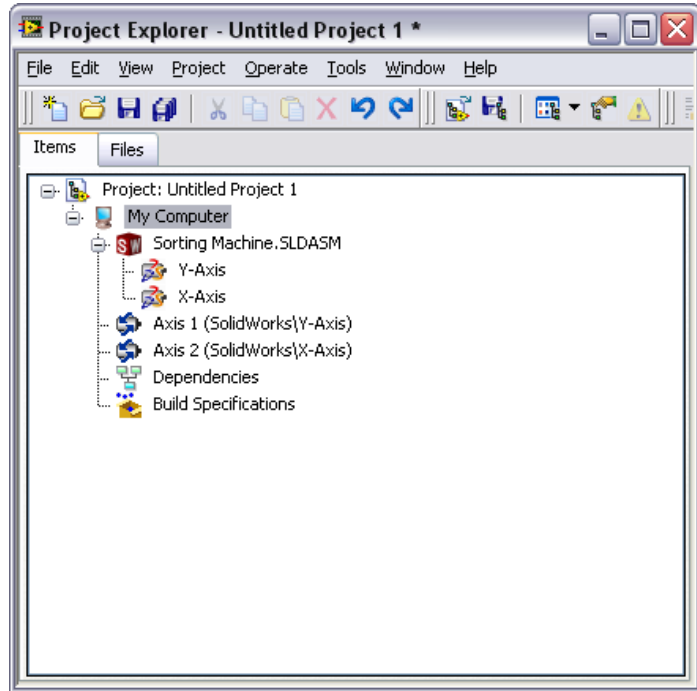
1. Right-click **My Computer** in the **Project Explorer** window and select **New»NI SoftMotion Axis** from the shortcut menu to open the **Axis Manager** dialog box, shown in Figure 2.
2. Select **Add New Axis**. The new axis automatically binds to an available SolidWorks motor. Double-click the axis name to rename the axis and give it a descriptive name.



**Figure 2.** Axis Manager Dialog Box

3. Click **Add New Axis** until all available SolidWorks motors are associated with NI SoftMotion axes.

4. Click **OK**. All axes are added to the **Project Explorer** window as shown in the following figure.

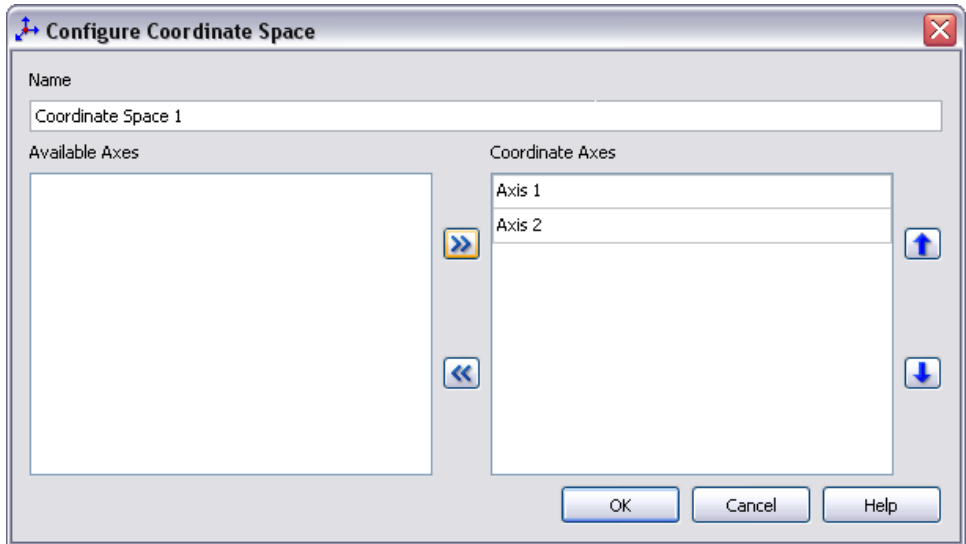


**Figure 3.** Project Explorer Window with a SolidWorks Assembly and NI SoftMotion Axes

## Adding Coordinates to the Project

NI SoftMotion axes can be grouped into coordinate spaces so that you can perform coordinated moves using multiple axes simultaneously. The coordinate spaces are used as inputs to your motion applications when performing coordinate moves. Complete the following steps to add a coordinate space to the project:

1. Right-click **My Computer** 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 position and other information is contained 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 and add the new coordinate space to the LabVIEW Project.

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

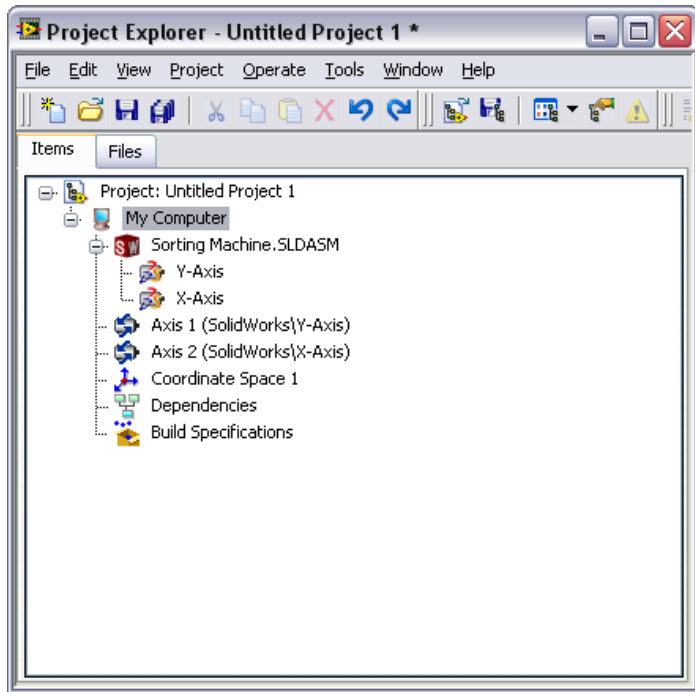


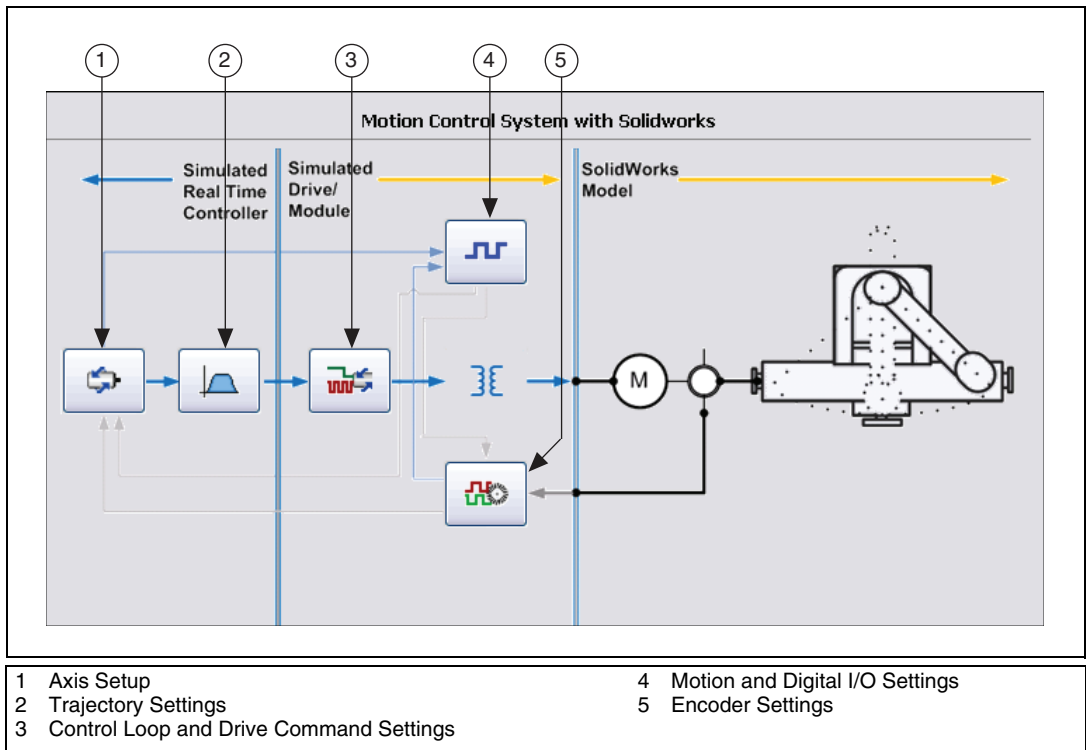
Figure 5. LabVIEW Project With NI SoftMotion Axes and Coordinates

## Step 2: Configuring the Axes

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Axes associated with SolidWorks motors are assumed to be servo motors. Since the axes are not associated with actual hardware, you only need to perform minimal configuration to get started. Once you set up your simulation, you can change configuration settings on the axes for easy deployment to the final hardware using the profiles you create. Complete the following steps to configure the axes for use in your simulation:

1. Right-click the axis in the **Project Explorer** window and select **Properties** from the shortcut menu to open the **Axis Configuration** dialog box. Figure 6 shows the parts of the **Axis Configuration** dialog box for SolidWorks axes. Items that are not applicable to your configuration are greyed out.



**Figure 6.** Axis Configuration Dialog Box for NI SoftMotion SolidWorks Axes



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

2. On the **Axis Setup** page confirm that the **Axis Enabled** and **Enable Drive on Transition to Active Mode** checkboxes contain checkmarks. This automatically activates all axes when the NI Scan Engine switches to Active mode.



**Tip** You can also use the Power function block in your VI to activate and enable axes.

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

# Step 3: Creating a Motion Profile and Running the Simulation

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You create motion profiles for simulation with the SolidWorks assembly using the NI SoftMotion function blocks on the **NI SoftMotion»Function Blocks** palette. The NI SoftMotion function blocks allow you to perform straight-line moves, arc moves, contoured moves, gearing and camming operations, and read status and data information. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for more information about using the NI SoftMotion function blocks.



**Note** If you are new to LabVIEW, refer to *Getting Started with LabVIEW*, at **Start»All Programs»National Instruments»LabVIEW»LabVIEW Manuals**, for more information about creating, editing, and using LabVIEW VIs.

## Configuring the Timed Loop

A Timed Loop synchronized to the NI Scan Engine allows your time-sensitive motion applications 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 allocations should be minimized in timed loops to avoid introducing jitter into the system.

NI SoftMotion function blocks are typically used on hardware running a real-time OS to create deterministic motion control applications. When you use NI SoftMotion function blocks on Windows with a SolidWorks simulation, the timing of the NI Scan Engine is not guaranteed. Refer to the *Using the NI Scan Engine* topic in the *LabVIEW Help* for more information.



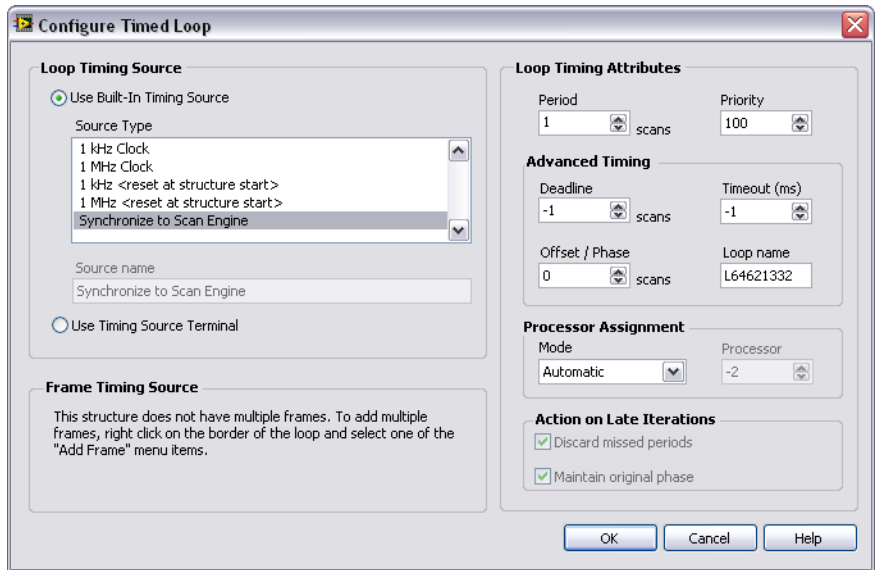
**Tip** If your code does not need to run at the scan rate, you can use a While Loop with a Wait Until Next ms Multiple function to control the loop rate.

Complete the following steps to configure the Timed Loop:

1. Right-click **My Computer** 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. The Timed Loop is located on the **Timed Structures** palette.
3. Double-click the **Input Node** of the Timed Loop to open the **Configure Timed Loop** dialog box.

- 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.

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



**Figure 7.** Configuring the Timed Loop

- Click **OK**.

## Creating a Move Profile

This example uses the NI SoftMotion Arc function block with the NI SoftMotion coordinate resource to perform a circular arc move to move the test tube.



**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 arc move:

- Place an Arc function block inside the Timed Loop.
- Right-click the **execute** input and select **Create»Control** from the shortcut menu to add a control to the front panel for this input.
- Repeat step 2 for the **position**, **velocity**, **acceleration**, **acceleration jerk**, **start angle**, **travel angle**, and **radius** inputs to add controls to the front panel for each of these inputs.

4. Wire the **deceleration** input to the **acceleration** control and the **deceleration jerk** input to the **acceleration jerk** control. In some applications, you may require your deceleration values to differ from your acceleration values, but this application will keep them the same.
5. Right-click the **done** output and select **Create»Indicator** from the shortcut menu to add an indicator to the front panel.
6. 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.
7. Right-click the **error out** output and select **Create»Indicator** from the shortcut menu to add an indicator to the front panel.
8. Wire the **error out** output to the edge of the Timed Loop.
9. 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.
10. Wire the **error in** input to the shift register created on the other side of the Timed Loop.
11. Right-click the left shift register and select **Create»Constant** from the shortcut menu to initialize the error cluster outside the Timed Loop. Because the final hardware will use the LabVIEW Real-Time module, all function block arrays and clusters are initialized outside the Timed Loop to prevent jitter in the system.
12. 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 Figure 8 when you have completed these steps.

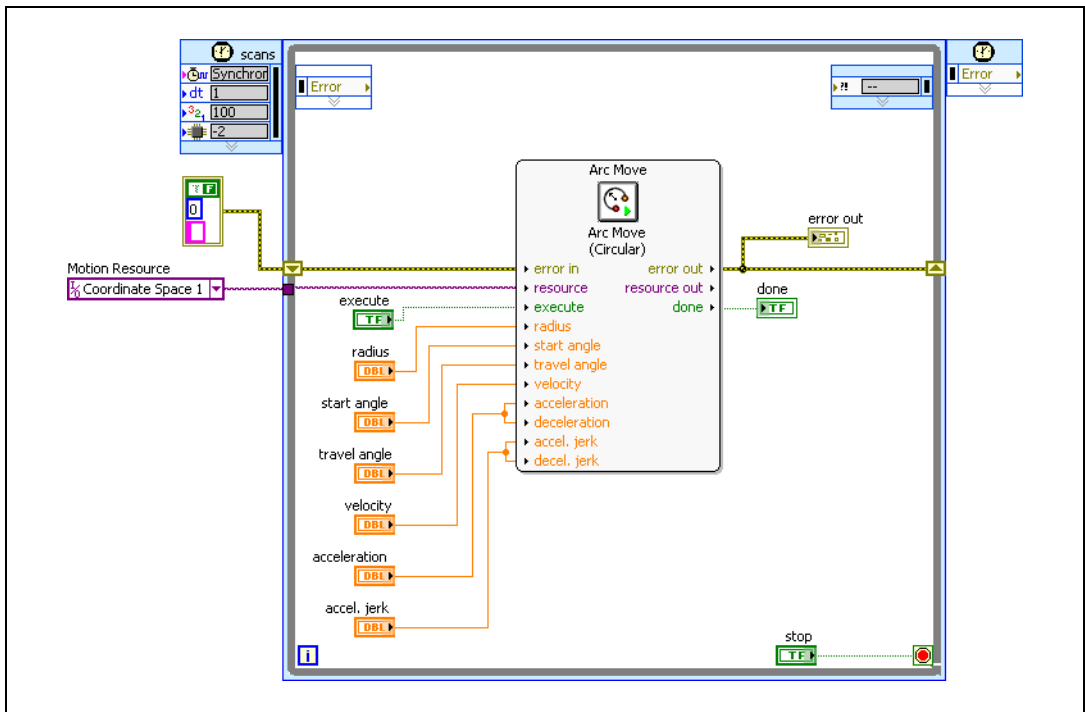


Figure 8. Tutorial VI Block Diagram

13. Navigate to the front panel and change the arc move parameters from the default values to the following:
  - **radius:** 50
  - **start angle:** 180
  - **travel angle:** 180
14. Keep the values for **velocity**, **acceleration**, and **acceleration jerk** at the defaults for now. You can change these values and run the simulation again to see how changes to the move constraints impact the system.
15. Save the VI.
16. Save the project.

## Deploying, Running, and Stopping the Simulation

Deploying the project and running the VI starts the SolidWorks simulation using the move profile you created. Complete the following steps to deploy and run the VI and start the SolidWorks simulation:

1. Right-click **My Computer** in the **Project Explorer** window and select **Properties** to display the **My Computer Properties** dialog box.
2. Select **Scan Engine** from the **Category** list and place a checkmark in the **Start Scan Engine on Deploy** checkbox.
3. Click **OK** to close the **My Computer Properties** dialog box.
4. Select the My Computer, SolidWorks assembly, axes, and coordinate items in the **Project Explorer** window, right-click and select **Deploy** from the shortcut menu. LabVIEW deploys all associated I/O resources and settings the VI uses, switches the NI Scan Engine to Active mode, and starts the SolidWorks simulation.



**Note** To ensure that your simulation deploys properly always deploy the NI SoftMotion axes and not just the My Computer item.

5. Run the VI. LabVIEW begins the simulation using the move profile you created. For subsequent simulations, you may need to manually switch to Active mode by selecting **Utilities»Scan Engine Mode»Switch to Active**.
6. Right-click **My Computer** in the **Project Explorer** window and select **Utilities»Scan Engine Mode»Switch to Configuration** to stop the SolidWorks simulation.
7. Save the SolidWorks model, LabVIEW Project, and LabVIEW VI you created to apply any changes made.

## Step 4: Deploying to Hardware (Optional)

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In this section you will deploy the code written using the SolidWorks assembly to a CompactRIO system containing two NI 9512 C Series stepper drive interface modules.

Complete the following steps to run your simulation code on an actual hardware target:



**Tip** Refer to the *Getting Started with NI 951x Modules and LabVIEW (Scan Interface)* document, installed at `labview\manuals`, for detailed instructions for steps 1 through 3.

1. Add the RT target containing the NI 9512 C Series modules to the project.
2. Create an NI SoftMotion axis for each module, then add them to a coordinate space.



**Note** You can also drag the axes created in the [Adding Axes to the Project](#) section of this document under the RT target and remap them to the NI 9512 modules using the **Axis Manager** dialog box. All configuration options you selected previously are maintained.

3. Configure the axes:
  - a. Right-click the axis in the **Project Explorer** window and select **Properties** from the shortcut menu to open the **Axis Configuration** dialog box.
  - b. On the **Axis Setup** page, confirm that **Loop Mode** is set to **Open-Loop**. Axes configured in open-loop mode produce step output but do not require feedback from the motor to verify position.
  - c. Also on the **Axis Setup** page, confirm that the **Axis Enabled** and **Enable Drive on Transition to Active Mode** checkboxes contain checkmarks.



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

- d. 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 **Motion I/O** page and remove the checkmarks from the **Enable** checkboxes in the **Forward Limit**, **Reverse Limit**, and **Home** sections.

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



**Note** Make sure that the units and scaling configured for **Steps Per Unit** (if applicable) and **Counts Per Unit** match your motion system requirements. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for more information.

- f. Click **OK** to close the **Axis Configuration** dialog box.
  - g. Repeat steps a through f for Axis 2.
4. Drag the VI created in your SolidWorks project to the cRIO target. LabVIEW automatically updates the resource associations to use the axes associated with the NI 9512 modules rather than the SolidWorks motors.
  5. Double-click the **Input Node** of the Timed Loop to open the **Configure Timed Loop** dialog box. Under **Loop Timing Attributes**, set the **Period** to **5** scans. In most cases it is not necessary for the function blocks to run as fast as the scan rate.



**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 in the *LabVIEW Help* for more information about deployment and deployment troubleshooting tips.

6. 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.
7. Run the VI. The VI and all associated resources are deployed to the hardware target.

# Where to Go for Support

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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.

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](http://ni.com/support) and follow the calling instructions or dial 512 795 8248. For telephone support outside the United States, contact your local branch office:

Australia 1800 300 800, Austria 43 662 457990-0,  
Belgium 32 (0) 2 757 0020, Brazil 55 11 3262 3599,  
Canada 800 433 3488, China 86 21 5050 9800,  
Czech Republic 420 224 235 774, Denmark 45 45 76 26 00,  
Finland 358 (0) 9 725 72511, France 01 57 66 24 24,  
Germany 49 89 7413130, India 91 80 41190000, Israel 972 3 6393737,  
Italy 39 02 41309277, Japan 0120-527196, Korea 82 02 3451 3400,  
Lebanon 961 (0) 1 33 28 28, Malaysia 1800 887710,  
Mexico 01 800 010 0793, Netherlands 31 (0) 348 433 466,  
New Zealand 0800 553 322, Norway 47 (0) 66 90 76 60,  
Poland 48 22 328 90 10, Portugal 351 210 311 210,  
Russia 7 495 783 6851, Singapore 1800 226 5886,  
Slovenia 386 3 425 42 00, South Africa 27 0 11 805 8197,  
Spain 34 91 640 0085, Sweden 46 (0) 8 587 895 00,  
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