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NI-9512

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

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 2011 (32-bit) or later
- LabVIEW NI SoftMotion Module Standard 2011 or later
- SolidWorks 2009 Service Pack 2.1 or later and SolidWorks Motion Simulation with the SolidWorks Motion 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 SolidWorks Motion add-in from the **Add-Ins** dialog box in SolidWorks, place a checkmark in both the left and right checkboxes. This automatically enables the SolidWorks Motion add-in when SolidWorks launches.

You can download a free 30-day trial of the required National Instruments software from 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 2011 or later
 - NI-RIO 4.0.0 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»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 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 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»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

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

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\SolidWorks\SolidWorks Files` directory. This model simulates an assembly that takes test tubes from one location and moves them to another.



Note Verify that the SolidWorks Motion add-in available from the **Tools** menu in SolidWorks contains a checkmark in both the left and right checkboxes. This automatically enables the SolidWorks Motion add-in when SolidWorks launches.

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.

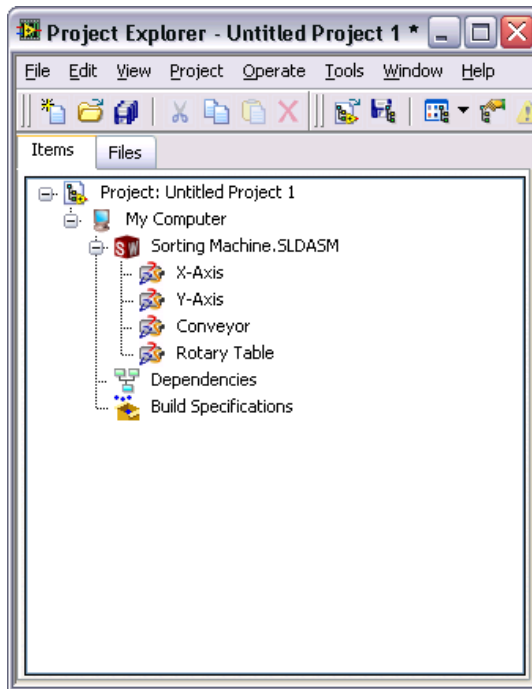


Figure 1. SolidWorks Assembly in the LabVIEW Project

- 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:

- 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.

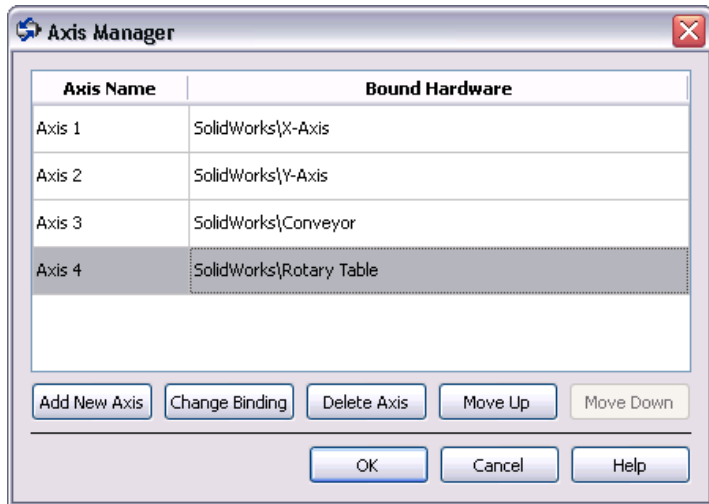


Figure 2. Axis Manager Dialog Box

- 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.

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.

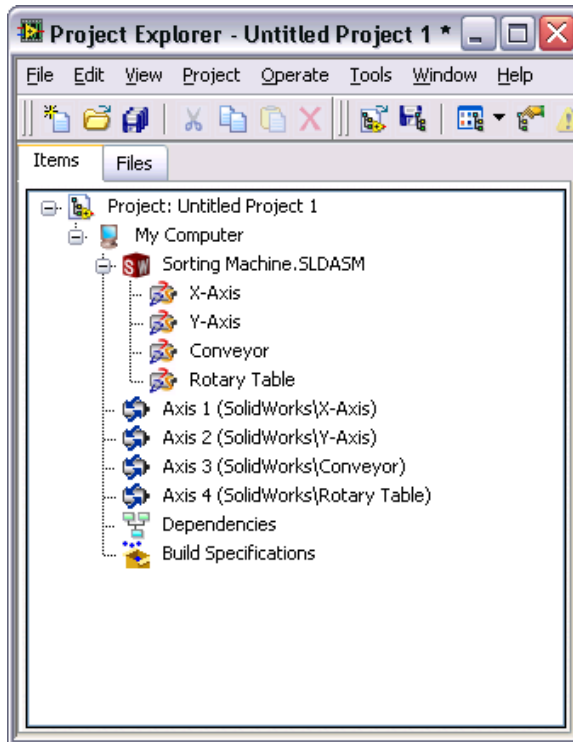


Figure 3. Project Explorer Window with a SolidWorks Assembly and NI SoftMotion Axes

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.

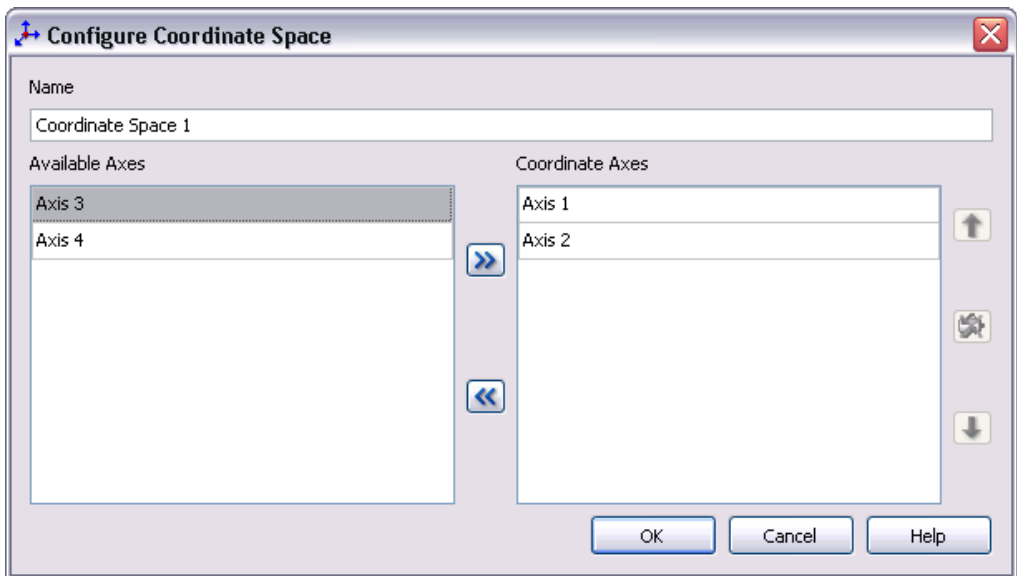


Figure 4. Configure Coordinate Space Dialog Box



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.

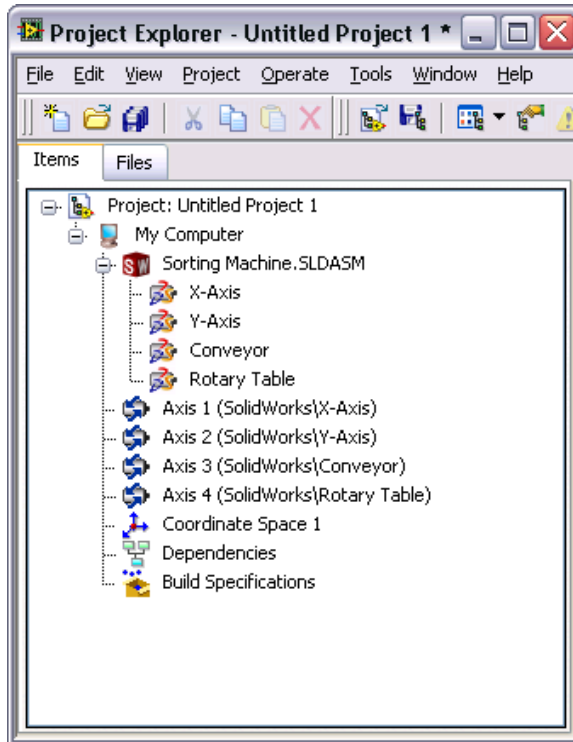


Figure 5. LabVIEW Project With NI SoftMotion Axes and Coordinates

Step 2: Configuring the Axes

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.

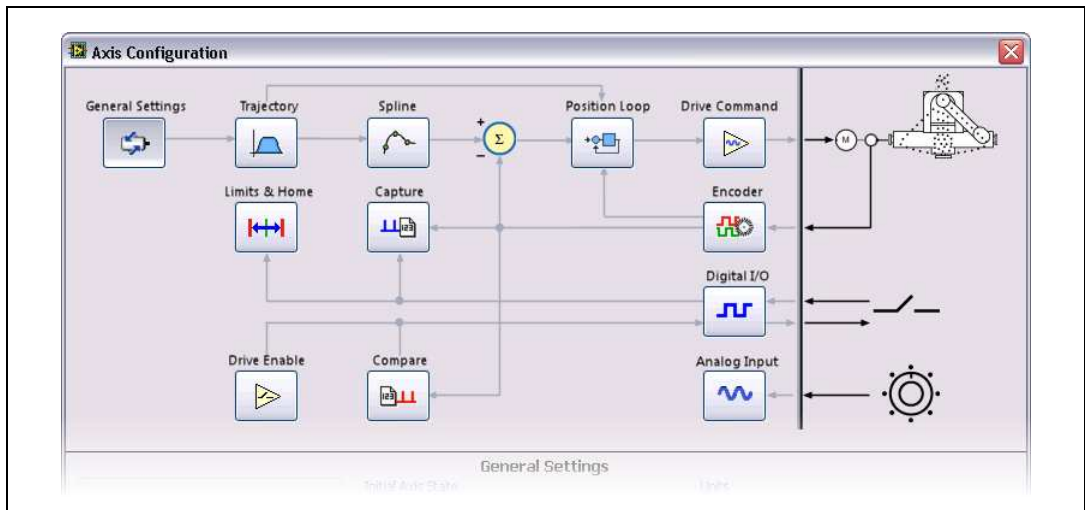


Figure 6. Axis Configuration Dialog Box for NI SoftMotion SolidWorks Axes



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

2. On the **General Settings** 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

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.

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.

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

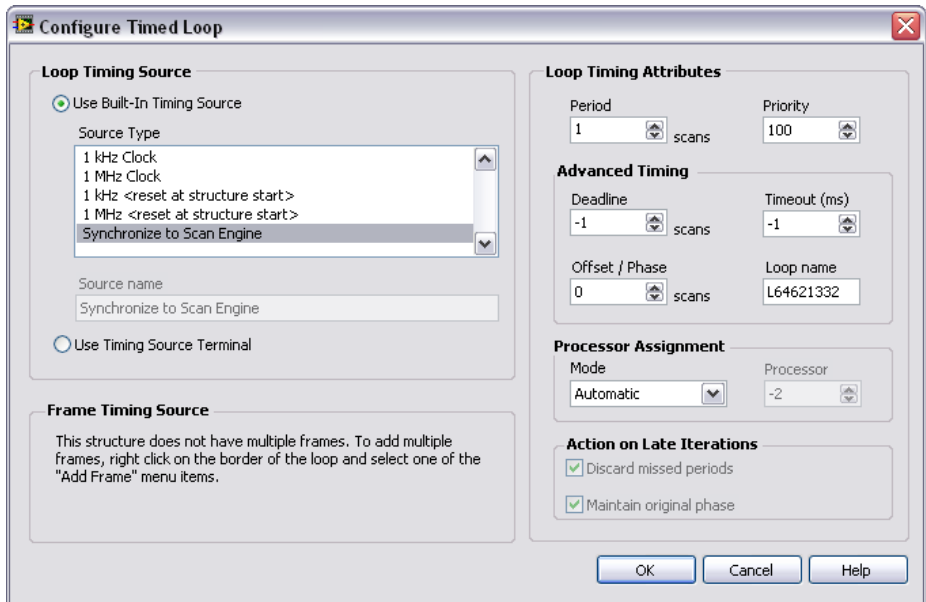


Figure 7. Configuring the Timed Loop

5. 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 deliver 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:

1. Place an Arc function block inside the Timed Loop. The NI SoftMotion function blocks are located on the **NI SoftMotion» Advanced** palette.
2. Right-click the **execute** input and select **Create»Control** from the shortcut menu to add a control to the front panel for this input.

3. Repeat step 2 for the **radius**, **start angle**, **travel angle**, **velocity**, and **acceleration** inputs to add controls to the front panel for each of these inputs.
4. Right-click the **done** output and select **Create»Indicator** from the shortcut menu to add an indicator to the front panel.
5. 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.
6. Right-click the **error out** output and select **Create»Indicator** from the shortcut menu to add an indicator to the front panel.
7. Wire the **error out** output to the edge of the Timed Loop.
8. 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.
9. Wire the **error in** input to the shift register created on the other side of the Timed Loop.
10. 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.
11. 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.

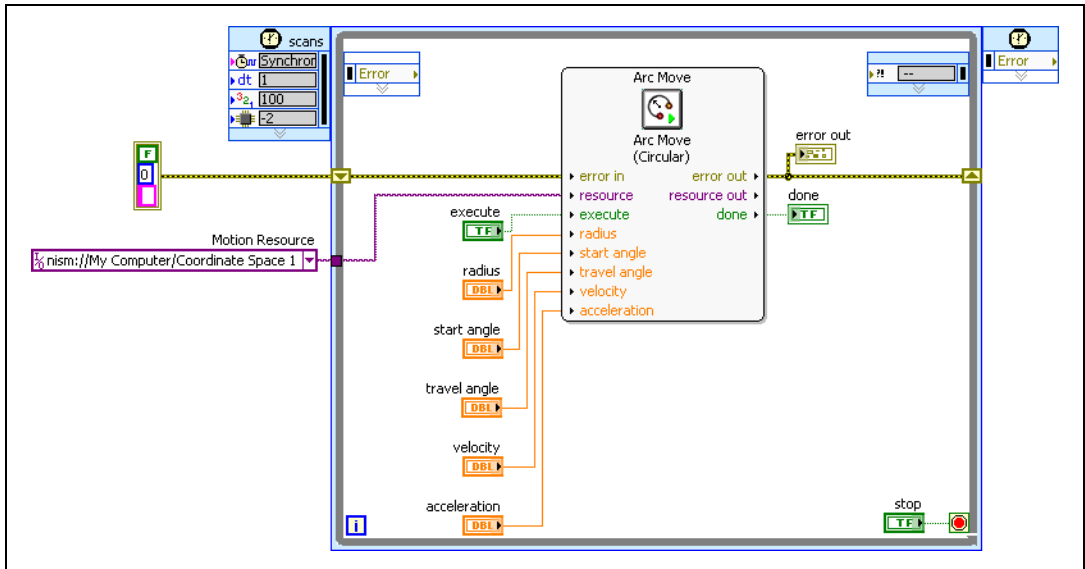


Figure 8. Tutorial VI Block Diagram

12. 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
13. Keep the values for **velocity** and **acceleration** 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.
14. Save the VI.
15. Save the project.

Deploying, Running, and Stopping the Simulation

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.



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

5. Right-click **My Computer** in the **Project Explorer** window and select **Utilities»Scan Engine Mode»Switch to Active** to verify that the NI Scan Engine is in Active mode. If the **Switch to Active** option is disabled in the shortcut menu the NI Scan Engine is already in Active mode.
6. Right-click the SolidWorks assembly and select **Start Simulation** to start the SolidWorks simulation.
7. Run the VI. LabVIEW acts on the SolidWorks assembly using the move profile you created.
8. Right-click the SolidWorks assembly in the **Project Explorer** window and select **Stop Simulation** to stop the SolidWorks simulation.
9. Save the SolidWorks model, LabVIEW Project, and LabVIEW VI you created to apply any changes made.

Step 4: Deploying to Hardware (Optional)

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* 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 **General Settings** 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 **General Settings** 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 **Limits & Home** page and remove the checkmarks from the **Enable** checkboxes in the **Forward Limit**, **Reverse Limit**, and **Home Switch** 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** on the **Stepper** page (if applicable) and **Counts Per Unit** on the **Encoder** page 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 and update 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.

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