

# Getting Started with NI Motion Assistant and LabVIEW

This tutorial is designed to help you rapidly create powerful motion control applications with NI Motion Assistant and LabVIEW. NI Motion Assistant is a LabVIEW add-on that provides a graphical, point and click interface with 3D visualization capabilities for controlling stepper, servo and piezo actuators. These three exercises will familiarize you with the NI Motion Assistant environment and teach you how to create your own NI Motion Assistant script and convert it to LabVIEW programs. Upon completion of the tutorial, you will be able to create motion control applications with straight line and arc moves with integrated data acquisition and image acquisition.

This tutorial covers only the beginning. Once you've finished, please feel free to explore the environment – NI Motion Assistant has numerous features to offer, including contoured moves with smart contouring, teach mode, jog axis and more. You can learn more about NI Motion Assistant at [ni.com/motion](http://ni.com/motion)

# Prototyping Your Semiconductor Wafer Heating Application using NI Motion Assistant and LabVIEW

The aim of this application is to move a semiconductor wafer on a linear stage into a furnace and keep it there for a specified burn-in period. After that the wafer is moved out of the furnace and replaced by another one.



The system is comprised of a linear stage that has an extended travel length. You can prototype the motion part of this application by creating a script in NI Motion Assistant using the following steps:

- Step 1. Reference Move—Moves the linear stage to its initial starting position by using the find home move type.
- Step 2. Straight-Line Move—Moves the wafer placed on the linear stage into the furnace.
- Step 3. Measurements—Waits for the specified amount of time for burn-in.
- Step 4. Straight-Line Move—Moves the wafer back to its original position.
- Step 5. Convert to LabVIEW or C code

## Step 1. Reference Move—Moves the linear stage to its initial starting position by using the find home move type.

Insert a Reference Move step to move the linear stage to its initial starting position.

1. Click the **Add Step** button on the far left side of the application window.
2. Click the **Reference Move** button.
3. Click the **Configure** tab on the dialog box at the bottom of the new screen.

- Because this application uses only one axis of motion, click the **1D** button.
  - **Device:** Choose the motion controller.
  - **Units:** Select counts (steps).
  - **Axis:** Choose the default Axis 1.
4. Click the **Move Constraints** tab on the dialog box. For moving a semiconductor wafer, which is not especially delicate, the default values are adequate:
    - **Profile type:** Select Trapezoidal.
    - **Velocity:** Enter 10,000 counts/sec.
    - **Acceleration:** Enter 100,000 counts/sec<sup>2</sup>.
    - **Deceleration:** Enter 100,000 counts (steps)/sec<sup>2</sup>.
  5. Click the Reference Parameters tab on the dialog box. For this application, a high-precision move is not necessary, so the following default settings are acceptable:
    6. Reference Type: Home
    7. Initial Direction: Forward
    8. Final Direction: Forward
    9. Edge to stop on: Forward
  10. Check the box next to the Reset Position Counters button to reset the position of the move to zero after the reference move.

## Step 2. Straight-Line Move—Moves the wafer placed on the linear stage into the furnace.

Insert a Straight-Line Move step. This step prototypes moving the wafer into the furnace.

1. Click the **Add Step** button on the far left side of the application window.
2. Click the **Straight-Line Move** button. Motion Assistant remembers the **Configure** and **Move Constraints** tab settings of the previous step, so it is necessary to change the settings only in the **Position** tab.
3. Click the **Position** tab on the dialog box, and set the following parameters:
  - **Operation Mode:** Absolute Position
  - **Position:** The number of counts (steps) to travel, which equates to distance, varies significantly for each motion system. For this example, enter 60000.

## Step 3. Measurements—Waits for the specified amount of time for burn-in.

Insert a Measurements step.

1. Click the **Add Step** button on the far left side of the application window.
2. Click the **Measurements** step button.

3. Click the **Configure Delay** tab on the dialog box, and set the following parameters:
  - **Type of Delay:** Wait for specified time
  - **Delay:** 5000 ms

This step sets a delay of five seconds that the wafer stays in the furnace for burn-in.

## **Step 4. Straight-Line Move—Moves the wafer back to its original position.**

Insert a second Straight-Line Move step. This step prototypes the removal of the wafer from the furnace.

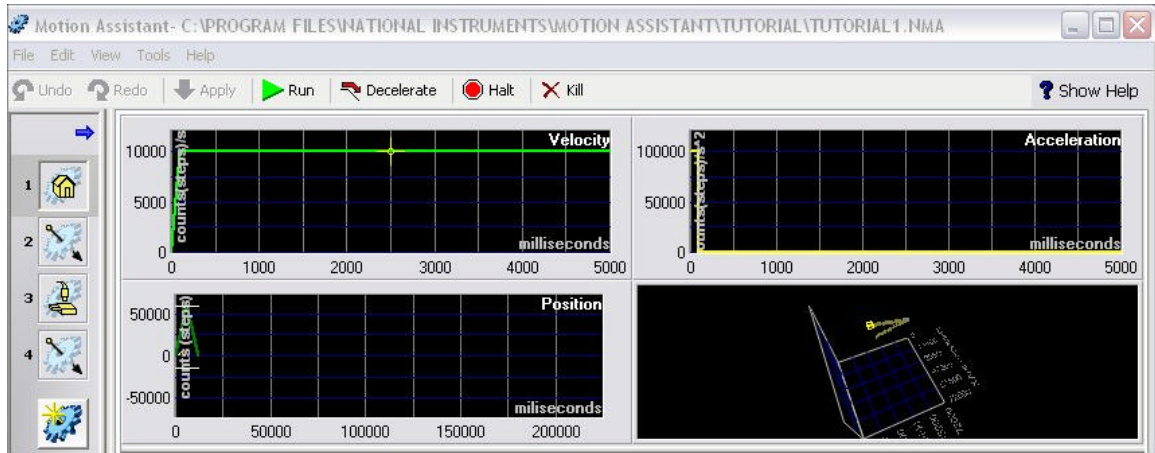
1. Click the **Add Step** button on the far left side of the application window.
2. Click the **Straight-Line Move** button. Motion Assistant remembers the **Configure** and **Move Constraints** settings from the previous step, so it is necessary to change the settings only in the **Position** tab.
3. Click the **Position** tab on the dialog box, and set the following parameters:
  - **Operation Mode:** Absolute Position
  - **Position:** The number of counts (steps) to travel, which equates to distance, varies significantly for each motion system. For this example, enter 0 to return the axis to its starting position.

## **Step 5. Convert to LabVIEW code**

You have finished creating the prototype motion script. You can now convert your Motion Assistant project to LabVIEW code by clicking **Tools»Generate Code»LabVIEW Diagram** in Motion Assistant.

## Completed Script

The following figure shows the velocity, acceleration, and position views of the moves generated in the script as well as a 3D view of the completed move profile.



Completed Semiconductor Wafer Heating Application Script

# 2

## Prototyping Your Part Inspection Application using NI Motion Assistant and LabVIEW

This application moves an XY stage under a camera through a specific path comprised of separate moves, pausing at the end of each move to capture an image. The devices being tested are placed at the end of each move segment. The move path is as follows:



The system is comprised of an XY stage with a camera mounted on top.

You can prototype the motion part of this application by creating a script in NI Motion Assistant using the following steps:

- Step 1. Reference Move—Moves the XY stage to its initial starting position by using the find home move type
- Step 2. Straight-Line Move—Moves from starting position A to position B
- Step 3. Measurements step—Placeholder for image acquisition action
- Step 4. Straight-Line Move step—Moves from position B to position C
- Step 5. Measurements step—Placeholder for image acquisition action
- Step 6. Straight-Line Move step—Moves from position C to position D
- Step 7. Measurements step—Placeholder for image acquisition action
- Step 8. Straight-Line Move step—Moves from position D back to position A

- Step 9. Measurements step—Placeholder for image acquisition action
- Step 10. Convert to LabVIEW or C code

## Step 1. Reference Move—Moves the XY stage to its initial starting position by using the find home move type

Insert a Reference Move step. This step moves the XY stage to its reference starting position.

1. Click the **Add Step** button on the far left side of the application window.
2. Click the **Reference Move** button.
3. Click the **Configure** tab on the dialog box at the bottom of the new screen.
4. Click the **2D** button. You configure this move as a 2D move because this application uses two axes of motion.
5. Enter the following information:
  - **Device:** Choose the motion controller.
  - **Units:** Select **counts (steps)**.
  - **Coordinate:** Select **Vector Space 1**.
  - **X Axis:** Choose the default, **Axis 1**.
  - **Y Axis:** Choose the default, **Axis 2**.
6. Click the **Move Constraints** tab on the dialog box. Moving heavy parts may require a gentler acceleration, so this example alters the following default values:
  - **Profile type:** Select **S-curve**.
  - **Velocity:** Enter 10,000 counts (steps)/sec.
  - **Acceleration:** Enter 100,000 counts (steps)/sec<sup>2</sup>.
  - **Deceleration:** Enter 100,000 counts (steps)/sec<sup>2</sup>.
  - **S-curve (Jerk):** Enter 400,000,000 counts (steps)/sec<sup>3</sup>.
7. Click the Reference Parameters tab on the dialog box. For this application, a high-precision reference move is unnecessary, so the following default settings are acceptable:
  - **Reference Type:** Home
  - **Initial Direction:** Forward
  - **Final Direction:** Forward
  - **Edge to stop on:** Forward
8. Check the box next to the **Reset Position Counters** button to reset the position of the move to zero after the reference move.

## Step 2. Straight-Line Move—Moves from starting position A to position B

Insert a Straight-Line Move step. This step moves the stage from point A to point B.

1. Click the **Add Step** button on the far left side of the application window.
2. Click the **Straight-Line Move** button. Motion Assistant remembers the **Configure** and **Move Constraints** tab settings of the previous step, so it is necessary to change the settings only in the **Position** tab.
3. Click the **Position** tab on the dialog box, and set the following parameters:
  - **Operation Mode:** Absolute Position
  - **X Position:** The number of counts (steps) to travel, which equates to distance, varies significantly for each motion system. For this example application, enter 50000.
  - **Y Position:** Enter 0 because the y-axis does not change from position A to position B.

### Step 3. Measurements step—Placeholder for image acquisition action

Insert a Measurements step.

1. Click the **Add Step** button on the far left side of the application window.
2. Click the **Measurements** step button.
3. Click the **Configure Delay** tab on the dialog box, and set the following parameters:
  - **Type of Delay:** Wait for specified time
  - **Delay:** 500 ms
4. Click the **Comment** tab on the dialog box, and enter text describing the image acquisition. This could be in the form of paragraphs or pseudocode.

This configuration of the Measurements step inserts a half-second delay between two straight-line moves, and adds a comment into the LabVIEW code and code recipe as a placeholder for the image acquisition code.

### Step 4. Straight-Line Move step—Moves from position B to position C

Insert a second Straight-Line Move step. This step prototypes the move from point B to point C.

1. Click the **Add Step** button on the far left side of the application window.
2. Click the **Straight-Line Move** button.
3. Click the **Position** tab on the dialog box, and set the following parameters:
  - **Operation Mode:** Absolute Position
  - **X Position:** For this example, enter 50000 because X does not change from position B to position C.

- **Y Position:** Enter –50000 because the y-axis changes from point B to point C.

## Step 5. Measurements step—Placeholder for image acquisition action

Insert a Measurements step.

1. Click the **Add Step** button on the far left side of the application window.
2. Click the **Measurements** step button.
3. Click the **Configure Delay** tab on the dialog box, and set the following parameters:
  - **Type of Delay:** Wait for specified time
  - **Delay:** 500 ms
4. Click the **Comment** tab on the dialog box, and enter text describing the image acquisition. This could be in the form of paragraphs or pseudocode.

This configuration of the Measurements step inserts a half-second delay between two straight-line moves, and adds a comment into the LabVIEW code and code recipe as a placeholder for the image acquisition code.

## Step 6. Straight-Line Move step—Moves from position C to position D

Insert the third Straight-Line Move step. This step prototypes the move from point C to point D.

1. Click the **Add Step** button on the far left side of the application window.
2. Click the **Straight-Line Move** button.
3. Click the **Position** tab on the dialog box, and set the following parameters:
  - **Operation Mode:** Absolute Position
  - **X Position:** Enter 0 because the x-axis moves back to its original position of zero.
  - **Y Position:** Enter -50000 because the y-axis does not change from point C to point D.

## Step 7. Measurements step—Placeholder for image acquisition action

Insert a Measurements step.

1. Click the **Add Step** button on the far left side of the application window.
2. Click the **Measurements** step button.
3. Click the **Configure Delay** tab on the dialog box, and set the following parameters:
  - a. **Type of Delay:** Wait for specified time

- b. **Delay:** 500 ms
4. Click the **Comment** tab on the dialog box, and enter text describing the image acquisition. This could be in the form of paragraphs or pseudocode.

This configuration of the Measurements step inserts a half-second delay between two straight-line moves, and adds a comment into the LabVIEW code and code recipe as a placeholder for the image acquisition code.

## Step 8. Straight-Line Move step—Moves from position D back to position A

Insert the fourth and final Straight-Line Move step. This step prototypes the move from point D back to point A to complete the square.

1. Click the **Add Step** button on the far left side of the application window.
2. Click the **Straight-Line Move** button.
3. Click the **Position** tab on the dialog box, and set the following parameters:
  - **Operation Mode:** Absolute Position
  - **X Position:** Enter 0 because the x-axis is already at its original position.
  - **Y Position:** Enter 0 because the y-axis returns to its original position to complete the square.

## Step 9. Measurements step—Placeholder for image acquisition action

Insert a Measurements step.

1. Click the **Add Step** button on the far left side of the application window.
2. Click the **Measurements** step button.
3. Click the **Configure Delay** tab on the dialog box, and set the following parameters:
  - **Type of Delay:** Wait for specified time
  - **Delay:** 500 ms
4. Click the **Comment** tab on the dialog box, and enter text describing the image acquisition. This could be in the form of paragraphs or pseudocode.

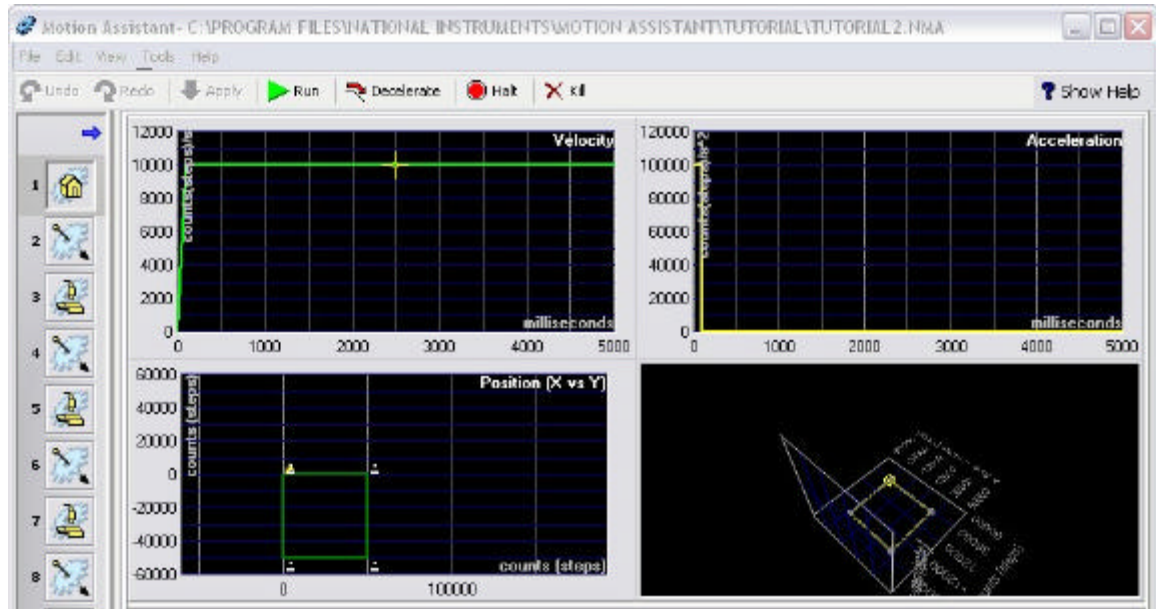
This configuration of the Measurements step inserts a half-second delay between two straight-line moves, and adds a comment into the LabVIEW code and code recipe as a placeholder for the image acquisition code.

## Step 10. Convert to LabVIEW or C code

You have finished creating the prototype motion script. You can now convert your Motion Assistant project to LabVIEW code by clicking **Tools»Generate Code»LabVIEW Diagram** in Motion Assistant.

## Completed Script

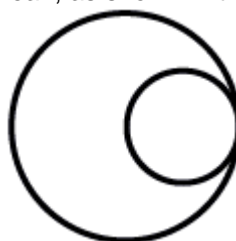
The following figure shows the velocity, acceleration, and position views of the moves generated in the script as well as a 3D view of the completed move profile.



Completed Part Inspection Application Script

# Prototyping Your Door-Knob Hole Cutting Machine using NI Motion Assistant and LabVIEW

This application cuts circular holes in wooden doors to place door knobs. The doors with slits made in them are placed under the saw. The saw is lowered into the slit and then moved in a circular pattern to ensure that a perfectly round hole is cut. The saw is made to move in two circles to make sure that the cut is clean, as shown in the figure.



The system is comprised of the following:

- A saw mounted on an XY stage
- A vertical axis that moves the saw assembly up or down to insert the saw into the pre-made slit in the door

You can prototype the motion part of this application by creating a script in NI Motion Assistant using the following steps:

- Step 1. Reference Move—Moves the XY stage into its starting position using the find home move type.
- Step 2. Reference Move—Moves the vertical axis into its initial position.
- Step 3. Straight Line Move—Moves the vertical axis down so that the saw is inserted into the pre-made slit in the door.
- Step 4. Arc Move—Moves the XY stage in a circle. This arc is configured for blending.
- Step 5. Arc Move—Moves the XY stage in another circle of half the radius of the previous arc.
- Step 6. Convert to LabVIEW or C code.

## Step 1. Reference Move—Moves the XY stage into its starting position using the find home move type.

Insert a Reference Move step.

1. Click the **Add Step** button on the far left side of the application window.
2. Click the **Reference Move** button.
3. Click the **Configure** tab on the dialog box at the bottom of the new screen.
4. Because this move operates the two axes of the XY stage, click the **2D** button.
  - **Device:** Choose the motion controller.
  - **Units:** Select counts (steps).
  - **Coordinate:** Select Vector Space 1.
  - **X Axis:** Choose the default, Axis 1.
  - **Y Axis:** Choose the default, Axis 2.
5. Click the **Move Constraints** tab on the dialog box. Enter the following parameters:
  - **Profile type:** Select Trapezoidal.
  - **Velocity:** Enter 20,000 counts (steps)/sec.
  - **Acceleration:** Enter 100,000 counts (steps)/sec<sup>2</sup>.
  - **Deceleration:** Enter 100,000 counts (steps)/sec<sup>2</sup>.
6. Click the **Reference Parameters** tab on the dialog box, and enter the following information:
  - **Reference Type:** Home
  - **Initial Direction:** Forward
  - **Final Direction:** Forward
  - **Edge to stop on:** Forward
7. Check the box next to the **Reset Position Counters** button to reset the position of the move to zero after the reference move.

## Step 2. Reference Move—Moves the vertical axis into its initial position.

Insert a Reference Move step.

1. Click the **Add Step** button on the far left side of the application window.
2. Click the **Reference Move** button.
3. Click the **Configure** tab on the dialog box at the bottom of the new screen.
4. Because this move operates the two axes of the XY stage, click the **2D** button.
  - **Device:** Choose the motion controller.
  - **Units:** Select counts (steps).
  - **Coordinate:** Select Vector Space 1.

- **X Axis:** Choose the default, Axis 1.
  - **Y Axis:** Choose the default, Axis 2.
5. Click the **Move Constraints** tab on the dialog box. Enter the following parameters:
    - **Profile type:** Select Trapezoidal.
    - **Velocity:** Enter 20,000 counts (steps)/sec.
    - **Acceleration:** Enter 100,000 counts (steps)/sec<sup>2</sup>.
    - **Deceleration:** Enter 100,000 counts (steps)/sec<sup>2</sup>.
  6. Click the **Reference Parameters** tab on the dialog box, and enter the following information:
    - **Reference Type:** Home
    - **Initial Direction:** Forward
    - **Final Direction:** Forward
    - **Edge to stop on:** Forward
  7. Check the box next to the **Reset Position Counters** button to reset the position of the move to zero after the reference move.

### **Step 3. Straight Line Move—Moves the vertical axis down so that the saw is inserted into the pre-made slit in the door.**

Insert a Reference Move step.

1. Click the **Add Step** button on the far left side of the application window.
2. Click the **Reference Move** button.
3. Click the **Configure** tab on the dialog box at the bottom of the new screen.
4. Because this move operates the two axes of the XY stage, click the **2D** button.
  - **Device:** Choose the motion controller.
  - **Units:** Select counts (steps).
  - **Coordinate:** Select Vector Space 1.
  - **X Axis:** Choose the default, Axis 1.
  - **Y Axis:** Choose the default, Axis 2.
5. Click the **Move Constraints** tab on the dialog box. Enter the following parameters:
  - **Profile type:** Select Trapezoidal.
  - **Velocity:** Enter 20,000 counts (steps)/sec.
  - **Acceleration:** Enter 100,000 counts (steps)/sec<sup>2</sup>.
  - **Deceleration:** Enter 100,000 counts (steps)/sec<sup>2</sup>.
6. Click the **Reference Parameters** tab on the dialog box, and enter the following information:
  - **Reference Type:** Home
  - **Initial Direction:** Forward
  - **Final Direction:** Forward

- **Edge to stop on:** Forward
7. Check the box next to the **Reset Position Counters** button to reset the position of the move to zero after the reference move.

#### **Step 4. Arc Move—Moves the XY stage in a circle. This arc is configured for blending.**

Insert a Reference Move step.

1. Click the **Add Step** button on the far left side of the application window.
2. Click the **Reference Move** button.
3. Click the **Configure** tab on the dialog box at the bottom of the new screen.
4. Because this move operates the two axes of the XY stage, click the **2D** button.
  - **Device:** Choose the motion controller.
  - **Units:** Select counts (steps).
  - **Coordinate:** Select Vector Space 1.
  - **X Axis:** Choose the default, Axis 1.
  - **Y Axis:** Choose the default, Axis 2.
5. Click the **Move Constraints** tab on the dialog box. Enter the following parameters:
  - **Profile type:** Select Trapezoidal.
  - **Velocity:** Enter 20,000 counts (steps)/sec.
  - **Acceleration:** Enter 100,000 counts (steps)/sec<sup>2</sup>.
  - **Deceleration:** Enter 100,000 counts (steps)/sec<sup>2</sup>.
6. Click the **Reference Parameters** tab on the dialog box, and enter the following information:
  - **Reference Type:** Home
  - **Initial Direction:** Forward
  - **Final Direction:** Forward
  - **Edge to stop on:** Forward
7. Check the box next to the **Reset Position Counters** button to reset the position of the move to zero after the reference move.

#### **Step 5. Arc Move—Moves the XY stage in another circle of half the radius of the previous arc.**

To ensure that the two arcs are blended smoothly, their angular velocities should remain the same. Therefore, this step is configured to move at half the velocity of the previous arc step.

1. Click the **Add Step** button on the far left side of the application window.
2. Click the **Reference Move** button.
3. Click the **Configure** tab on the dialog box at the bottom of the new screen.

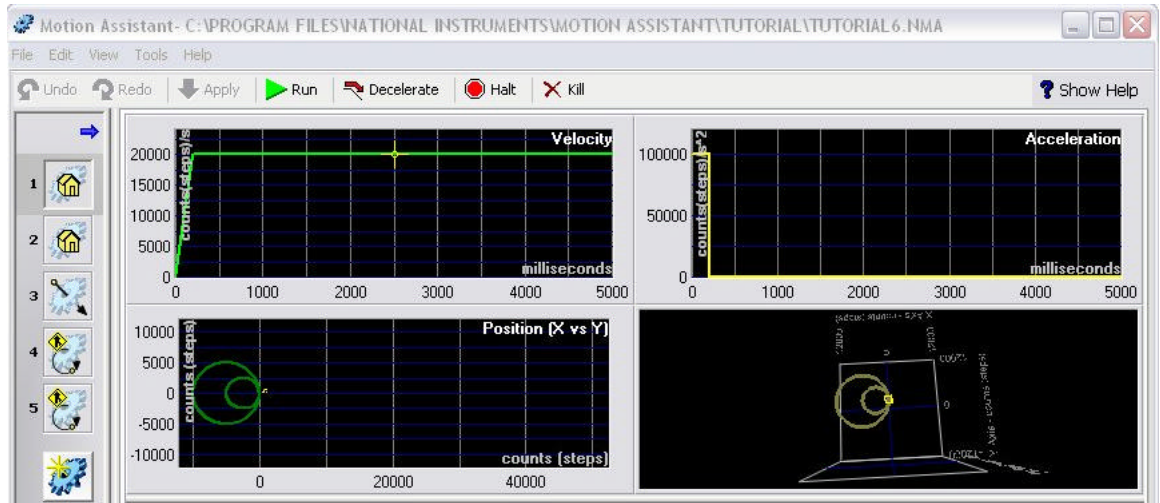
4. Because this move operates the two axes of the XY stage, click the **2D** button.
  - **Device:** Choose the motion controller.
  - **Units:** Select counts (steps).
  - **Coordinate:** Select Vector Space 1.
  - **X Axis:** Choose the default, Axis 1.
  - **Y Axis:** Choose the default, Axis 2.
5. Click the **Move Constraints** tab on the dialog box. Enter the following parameters:
  - **Profile type:** Select Trapezoidal.
  - **Velocity:** Enter 20,000 counts (steps)/sec.
  - **Acceleration:** Enter 100,000 counts (steps)/sec<sup>2</sup>.
  - **Deceleration:** Enter 100,000 counts (steps)/sec<sup>2</sup>.
6. Click the **Reference Parameters** tab on the dialog box, and enter the following information:
  - **Reference Type:** Home
  - **Initial Direction:** Forward
  - **Final Direction:** Forward
  - **Edge to stop on:** Forward
7. Check the box next to the **Reset Position Counters** button to reset the position of the move to zero after the reference move.

## Step 6. Convert to LabVIEW code.

You have finished creating the prototype motion script. You can now convert your Motion Assistant project to LabVIEW code by clicking **Tools»Generate Code»LabVIEW** Diagram in Motion Assistant.

## Completed Script

The following figure shows the velocity, acceleration, and position views of the moves generated in the script as well as a 3D view of the completed move profile.



Completed Door-Knob Hole Cutting Machine Script