LISTEN. THINK. SOLVE.

Introduction to Kinetix Integrated Motion with CompactLogix and the Kinetix 2000 Drive

ALLEN-BRADLEY • ROCKWELL SOFTWARE Rockwell Automation

Introduction to Kinetix Integrated Motion with CompactLogix and the Kinetix 2000 Drive: Hands-On Lab

Training Lab Manual

Welcome to the Introduction to Kinetix Integrated Motion Hands-On Lab

About This Hands-On Lab

This lab exercise demonstrates the following concepts of Kinetix Integrated Motion:

- Time efficient nature of using an integrated motion solution
- Power and performance-oriented nature of the integrated motion solution

You will be introduced to the RSLogix5000 software environment as the single software tool used by the Rockwell Automation integrated motion solution for configuration, programming, and troubleshooting and the inherent ease with which you can define your motion process. You will see how easy it is to create an integrated motion solution by doing the following:

- Creating and configuring motion axes using RSLogix5000
- Learning some basic motion instructions
- Using trends to demonstrate electronic gearing
- Duplicating and modifying a motion axis

During this lab you will be able to understand how Logix can help you reduce the number of hardware and software components as well as the flexibility associated with information/data access in the control system.

Lab Materials

We have provided you with the following materials so that you can complete the labs in this workbook:

Software

The PC in front of you has been loaded with following:

- RSLogix5000 v17
- RSLinx

Lab Files

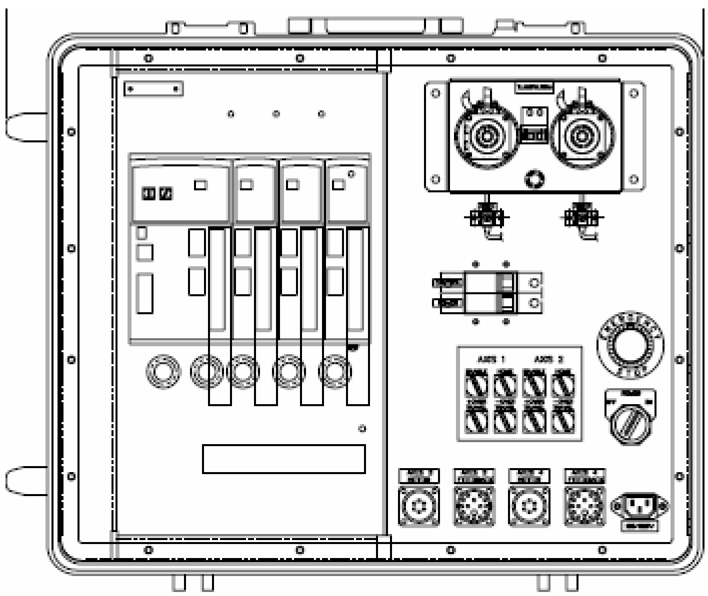
The following files will be used in this lab exercise:

- ABLogo.acd
- Intro_to_Kinetix_Integrated_Motion_CMP.acd

Hardware

- CompactLogix demo box

- K2K demo box



Note: Not all Kinetix 2000 cases have the same hardware! Check your case for modules:

2093-AC05-MP1

2093-AMP1

Document Conventions

Throughout this workbook, we have used the following conventions to help guide you through the lab materials.

This style or symbol:	Indicates:
Words shown in bold italics (e.g., ***RSLogix5000*** or ***OK***)	Any item or button that you must click on, or a menu name from which you must choose an option or command. This will be an actual name of an item that you see on your screen or in an example.
	The text that appears inside of this gray box is supplemental information regarding the lab materials, but not information that is required reading in order for you to complete the lab exercises. The text that follows this symbol may provide you with helpful hints that can make it easier for you to use this product. Most often, authors use this "Tip Text" style for important information they want their students to see.

Note: If the mouse button is not specified in the text, you should click on the left mouse button.

Before You Begin

The following steps must be completed before starting the lab exercises:

1. **Close** all open applications.

2. Locate the service tray in the lower right corner of the computer desktop:

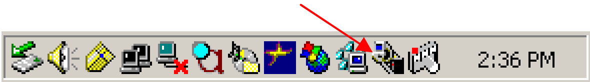
3. If the RSLinx icon still appears in the service tray in the lower right corner of the computer desktop, right click on the RSLinx icon and choose **Shutdown RSLinx**.

   RSLinx should shutdown.

4. From the computer desktop, double-click on the **RSLinx Classic** icon. 

   This will launch the software in the computer service tray.

5. Click on the **RSLinx** icon in the service tray.



6. When you have verified the path, click **Apply**, then **Done**, and exit RSLinx.

7. On the CompactLogix demo box, ensure that switches **DI4** and **DI5** are turned to the left (full counterclockwise position).

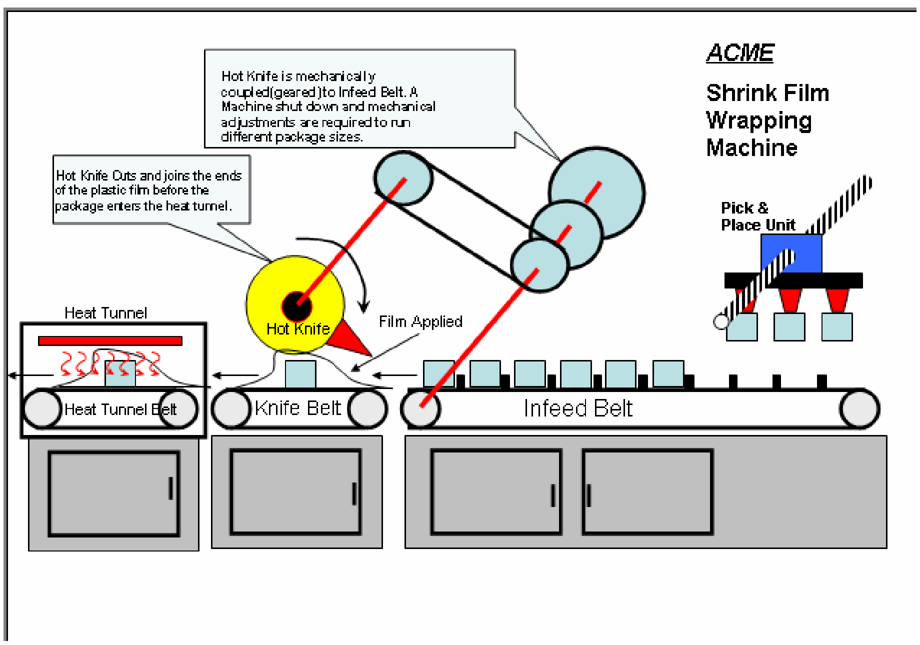
8. On the K2K demo box, ensure that both **ENABLE** switches are turned to the right.

9. Proceed to the next lab section.

The Customer Situation

You're experiencing increased demand for your packaging services. To meet demand, you purchased 50 used Shrink Film Wrapping Machines at a recent auction. The machines were mechanically sound, but the control system is dated.

The operation of the machine is simple. Packages are placed on an Infeed Belt that advances the packages to the Hot knife area where they are inserted into a loose fitting plastic film. The film is fed from a web and surrounds the package entirely. The Hot Knife's rotation is synchronized (mechanically coupled) with the Infeed Belt speed and it seals the film on the leading and trailing edge of the package. The trailing edge seal becomes the leading edge seal for the next package on the belt. The package then travels through the Heat Tunnel where the film shrinks tightly to the box. The figure below provides a basic diagram of the machine. The film web and applicator mechanism are excluded to simplify the drawing.



The current mechanical design requires the operator to stop the machine, and make mechanical adjustments to the pulley mechanisms to synchronize the Hot Knife to the Infeed belt when a package size change is required. This leads to costly set up charges and reduced production efficiencies.

The Existing Control System consists of the following:

- DC Motor & Drive (Coupled to Infeed Belt). Speed is controlled through a potentiometer. All other speed synchronization is done mechanically.
- PLC to control the Sequential Logic of the Machine.
- Separate Temperature Controllers on the Hot Knife and Heat Tunnel.

You need a control system that will provide the following benefits:

- Integrated Motion, Sequential Logic, and precise temperature control (PID) to eliminate the standalone temperature controllers
- An expandable system capable of handling the addition of axes, for future pick and place units or controlling multiple machines.
- Future connectivity to Rockwell Automation Visualization Products
- Future connectivity to the plant wide network for production scheduling and recipe download
- Efficient method of synchronizing the machinery with an existing Plant Wide Material Handling System (Logix controlled)

You realize immediately that the Logix Integrated Motion solution with Kinetix drives offers all of this and more!!

Lab 1: Creating & Configuring Integrated Motion Axes (approx. 20 min.)

Opening RSLogix5000 and Creating Axis Tags

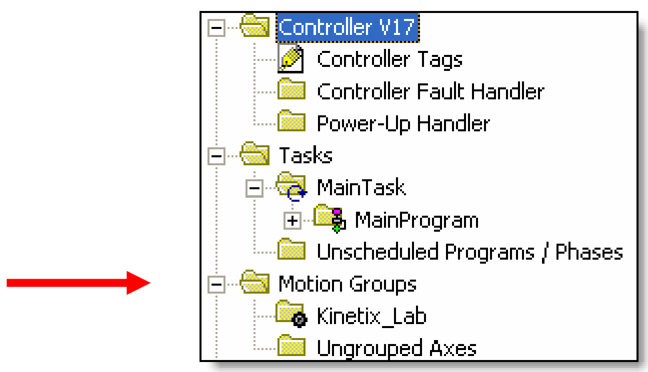
For the initial system, you have decided to replace the old controls with a CompactLogix System using Kinetix 2000 Drives, but you need to familiarize yourself with the Logix Motion Instructions required to run the Shrink Wrap Machine.

1. Follow the instructions in the **Before You Begin** section of this document before proceeding.

2. From the computer desktop, double-click on the **Working Folder.** 

3. Double-click the **Intro_to_Kinetix_Integrated_Motion_CMP.ACD** file to launch the project in RSLogix5000.

4. In the **Controller Organizer**, locate the **Motion Groups** folder and expand it to view its contents. Notice that the Motion Group **Kinetix_Lab** has already been created for you as shown below:

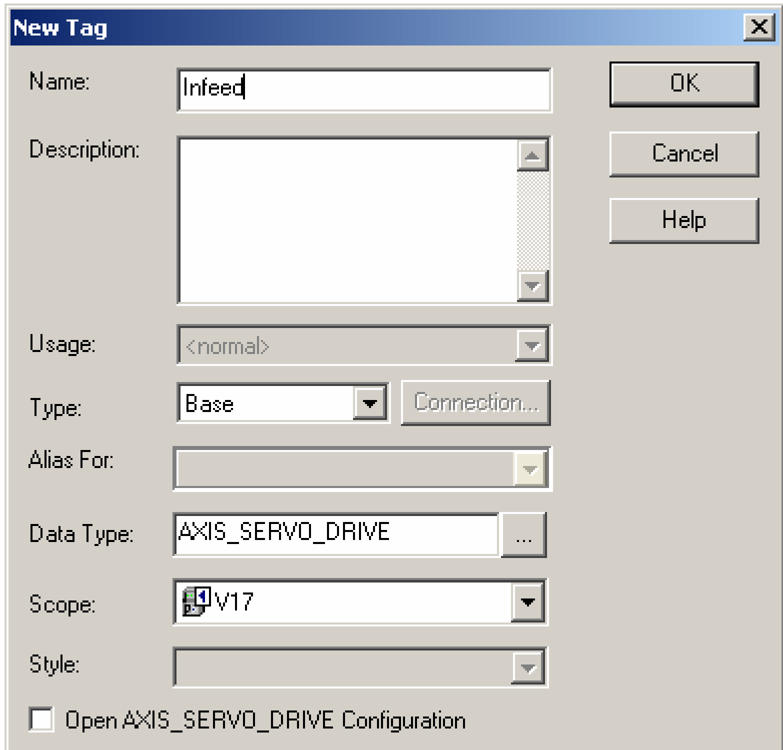


Let's create a motion axis tag.

5. Right click on the **Kinetix_Lab** motion group and select **New Axis > AXIS_SERVO_DRIVE**.

   The New Tag dialog box appears.

6. Enter the parameters as shown below. Accept your changes by clicking **OK**.

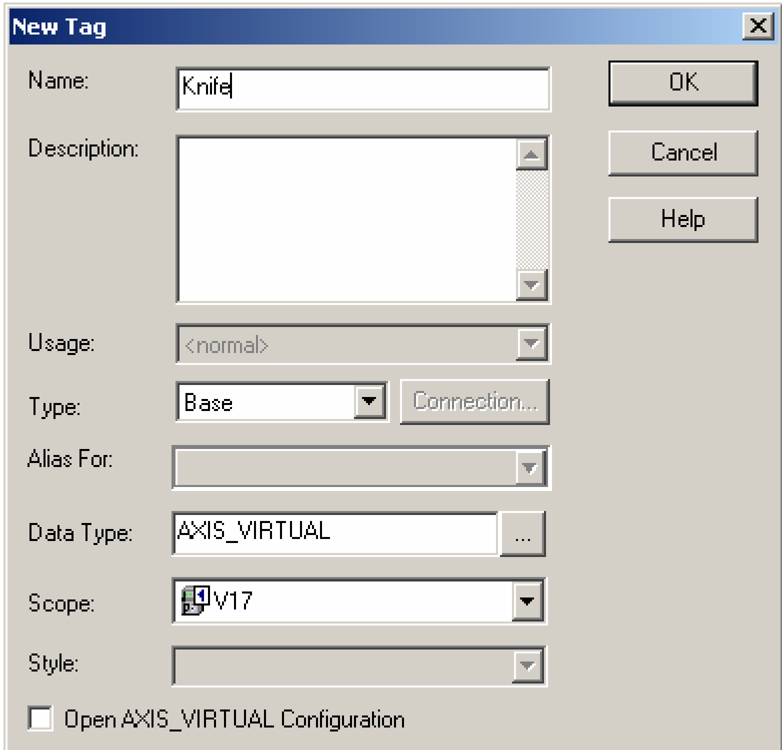


You just created your first motion axis! This axis will control the Infeed Belt in our packaging system. Now we're going to create an axis for controlling the hot knife.

7. Right-click on the **Kinetix_Lab** motion group and select **New Axis > AXIS_VIRTUAL**.

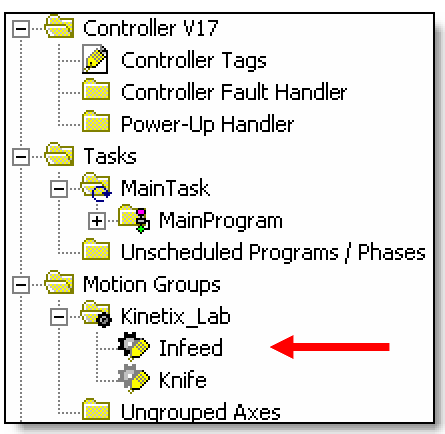
   The New Tag dialog box appears.

8. Enter the parameters as shown below, then accept your changes by clicking ***OK***.



Virtual axes are useful when multiple axes need to be coordinated/geared from a master reference. Electronic Line shaft applications are a typical example of systems that take advantage of our virtual axis capabilities.

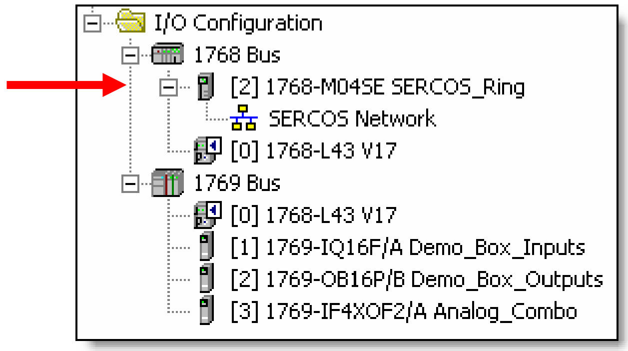
9. Verify that your Controller Organizer appears as shown below with the Infeed and Knife axes you just created.



Creating the Kinetix Drive Module

1. In your Controller Organizer locate the I/O Configuration folder and expand it to view its contents.

   Notice that the **SERCOS** module in **slot 2** of the CompactLogix system has already been configured for you as shown below. This is the interface to the Kinetix 2000 drive you see in the demo case.

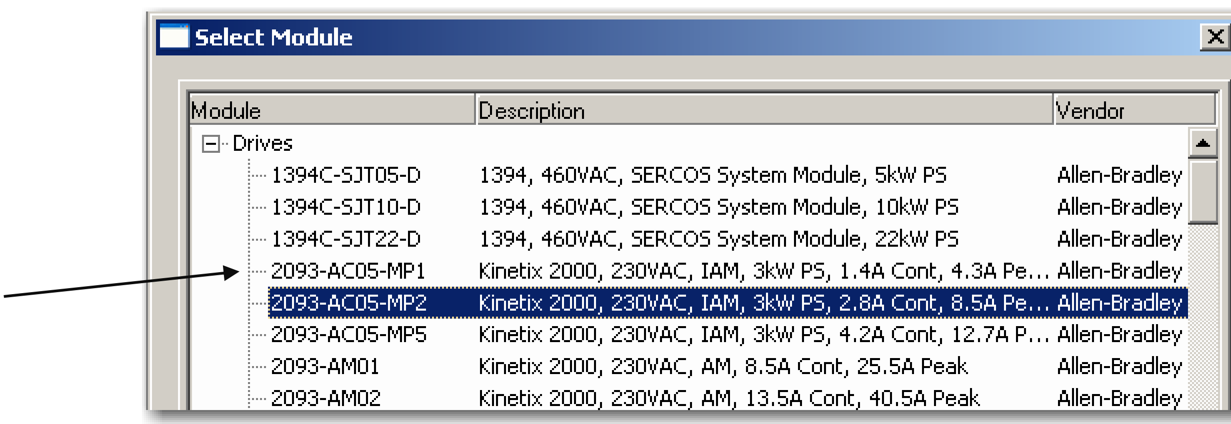


Let's go ahead and configure the Kinetix 2000 drive.

2. From the **I/O Configuration** in the Controller Organizer, right-click on the **1768-M04SE** and select **New Module**.

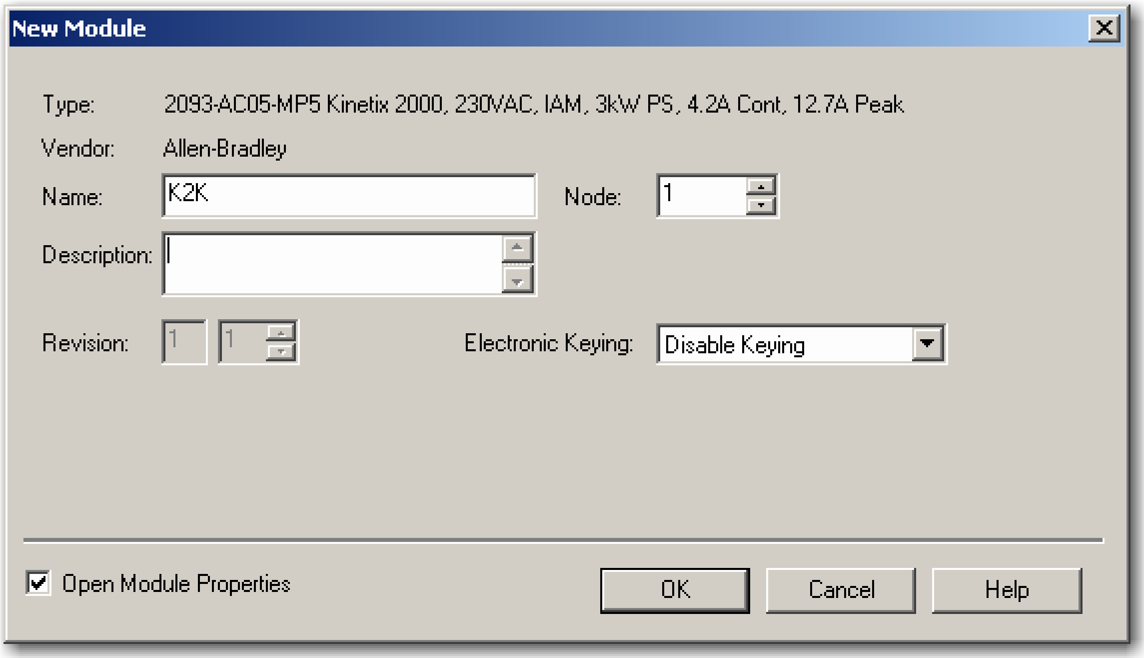
3. Expand the **Drives** selection to view a list of available devices.

4. Scroll down the list of drives to select the **2093-AC05-MP1** drive as shown below, then click **OK** to accept your choice.



This is the catalog number of the Kinetix 2000 drive in your demo box.

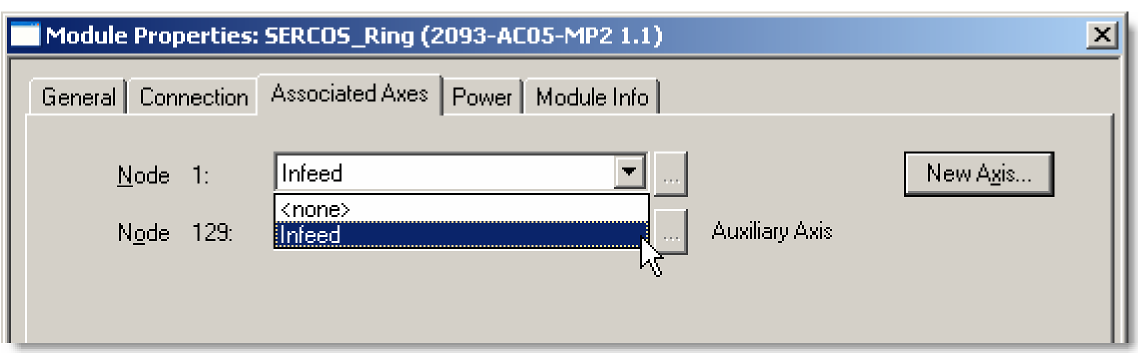
5. When the **Module Properties** dialog box appears, enter the parameters as shown below. Click the **OK**.



The Module Properties dialog appears.

You've created your Motion Axis and Drive module. Now we need to assign the axis to the drive you created.

6. Select the **Associated Axes** tab and select the **Infeed** axis you created earlier from the drop-down for **Node 1**.

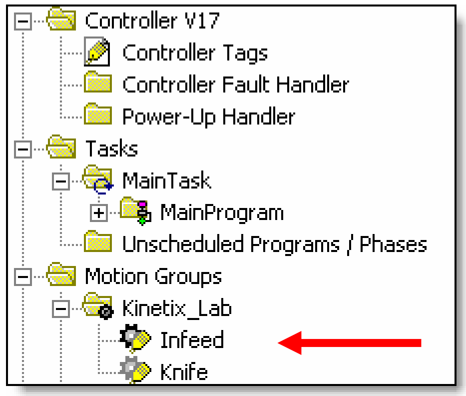


7. Click **OK** to accept changes.

Configuring the Infeed Belt Axis

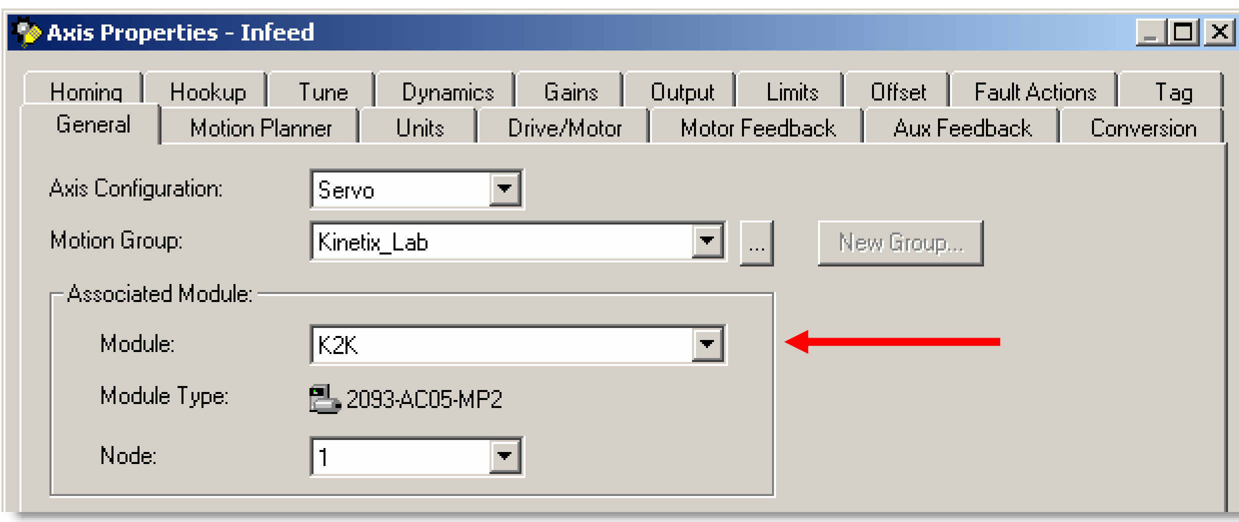
RSLogix5000 allows you to configure and assign an axis using multiple methods. We're going to use the **Axis Properties** dialog as it simplifies the configuration process. Let's see how easy it is to configure your Infeed Belt axis.

1. Launch the **Axis Properties** dialog by double-clicking on the **Infeed** axis you created.



   The **Axis Properties** dialog box opens to the **General** tab.

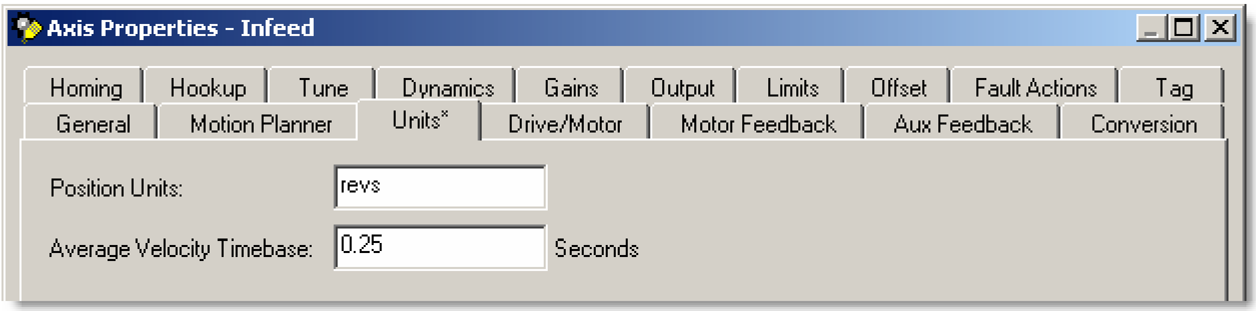
2. From the **General** tab, you can see the **Infeed** axis is assigned to the Kinetix 2000 drive module you added to the I/O Configuration.



   Notice that the **Module Type** field is populated for you. Remember that you chose this catalog number for the Kinetix 2000 drive when you added it to the I/O Configuration.

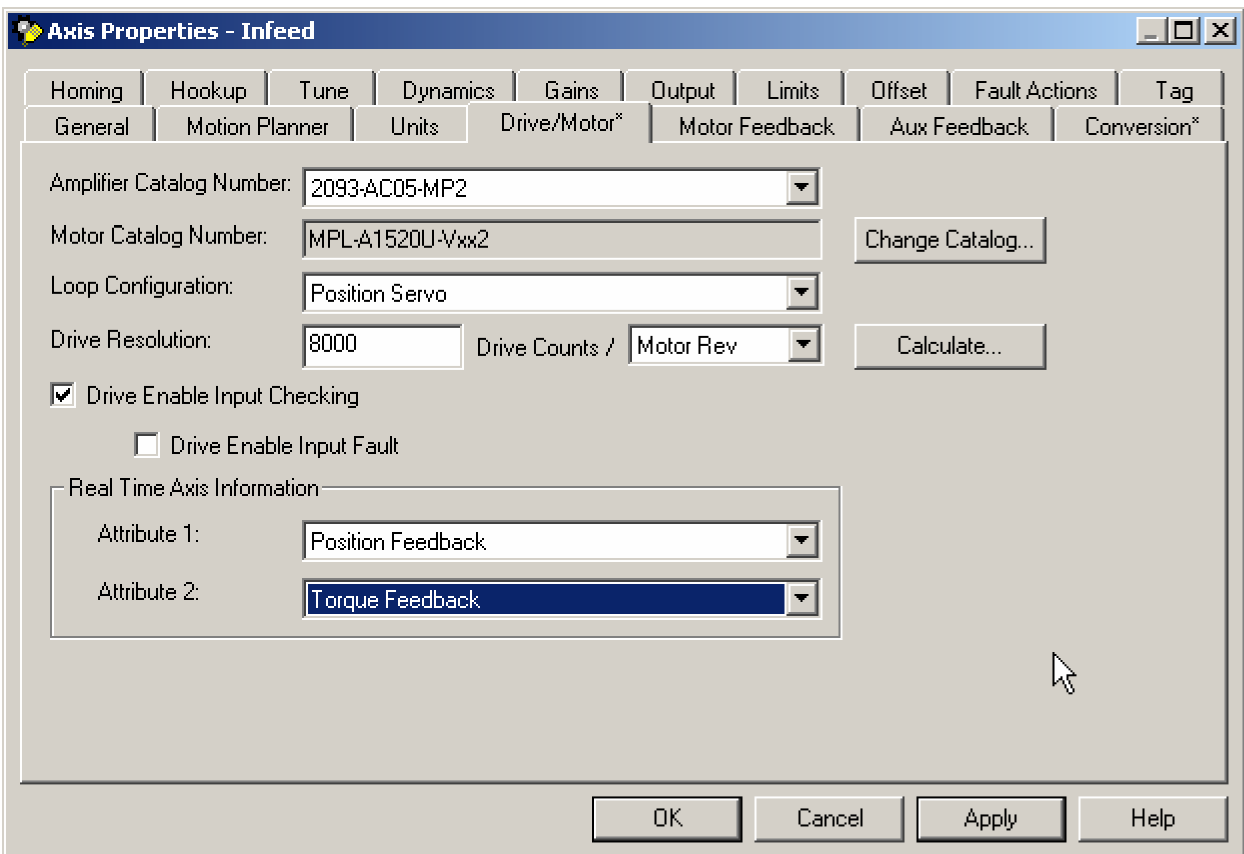
3. Click on the **Motion Planner** tab and review the parameters. We'll keep the default settings.

4. Click on the **Units** tab. Revolutions will be used for our unit of measure. The **Average Velocity Timebase** is the timeslice used to calculate the average velocity. Change the parameters to appear as shown below. Click **Apply** to accept changes.



5. Now click on the **Drive/Motor** tab and change all the parameters to appear as shown below.

   Note: In order to change the **Motor Catalog Number**, you must first click the **Change Catalog** button. The motor in the demo is **MPL-A1520U-Vxx2**.



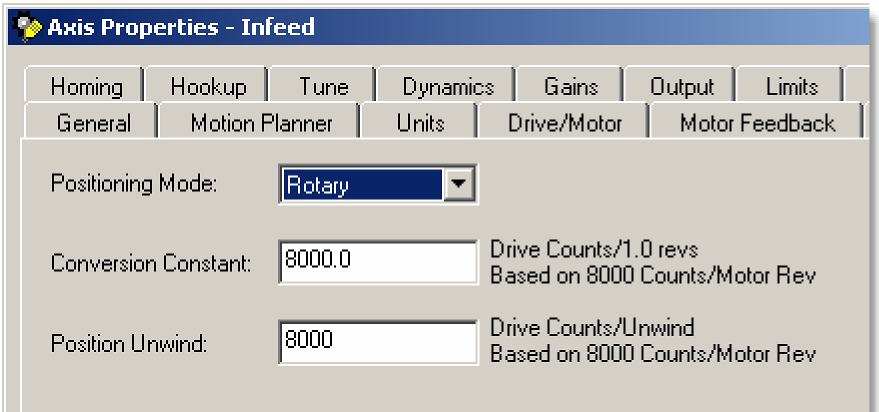
6. Click **Apply** to accept your changes.

7. In the **Motor Feedback** tab, notice that the parameters are defined for you. This is the result of you defining the motor catalog number on the Drive/Motor tab.

8. Click on the **Conversion** tab.

   These parameters are used to scale drive counts into usable engineering units (revs in this application). The Infeed Belt should be configured as a Rotary Axis. The pitch diameter of the belt roll is designed to move one package length per revolution of the motor for the largest package length as defined in the machine specification. Package spacing is determined by pin spacing on the belt. The old mechanical design required a pulley ratio of **(1:1)** between the Hot Knife and the Infeed Belt to move the largest packages through the machine.

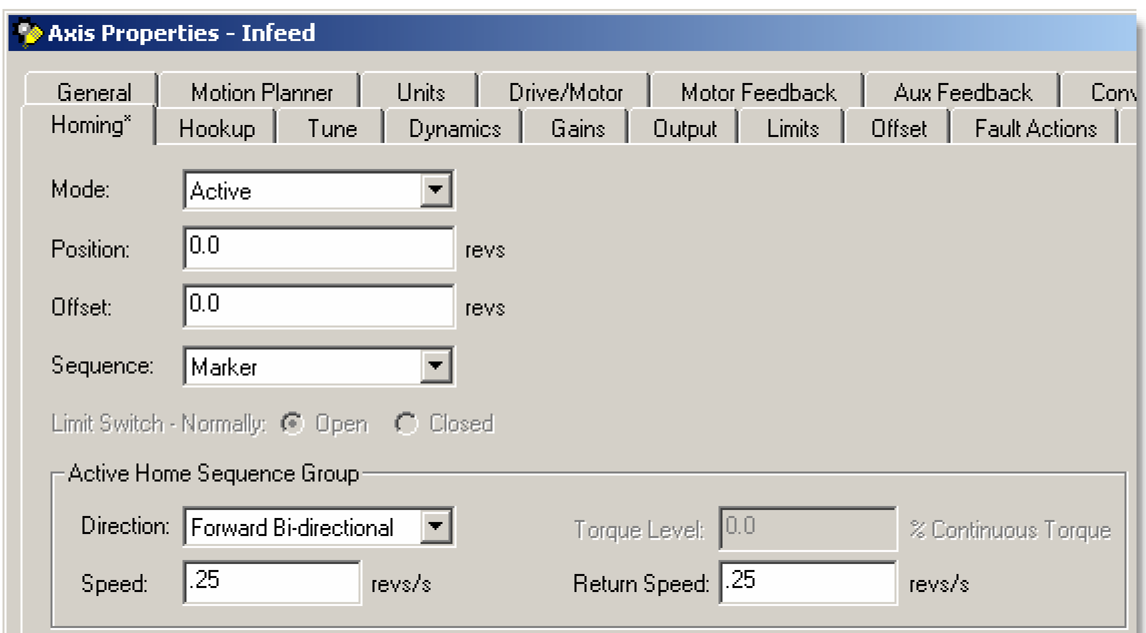
9. Set the parameters as shown below. Click **Apply** to accept changes.



10. When asked if you want the dependent attributes automatically updated, click **Yes**.

11. From the **Homing** tab, enter the parameters as shown below.

The attributes you choose here will define the Homing Sequence. We will Home to a marker to assure synchronization between the Infeed Belt and Knife axes.



The remaining tabs in the Infeed Axis Properties cover axis tuning. These steps must be completed later after downloading our program to the CompactLogix controller.

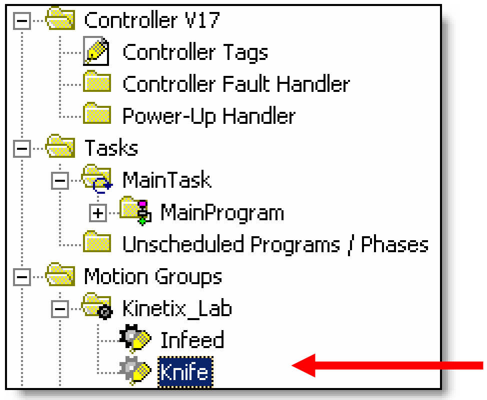
12. **Apply** your changes and click **OK** to exit the Axis Properties.

Great!! Your Infeed Belt Axis configuration is complete. Let's go ahead and configure our Knife axis.

Configuring the Hot Knife Axis

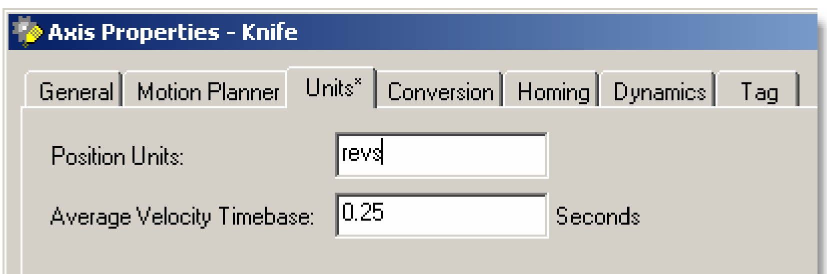
Again, we'll use the **Axis Properties** dialog to configure our Hot Knife axis. Remember that this axis has been configured as **AXIS_VIRTUAL**. Let's see how easy it is to configure your Hot Knife axis.

1. Open the **Axis Properties** dialog by double-clicking on the **Knife** axis you created earlier.

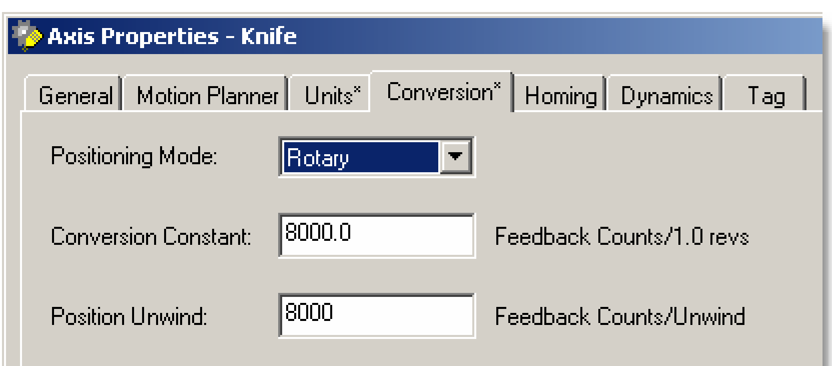


The Axis Properties dialog box opens to the General tab.

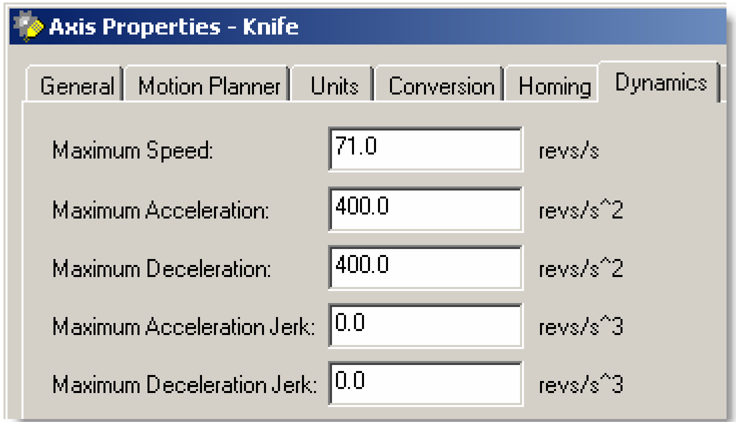
2. On the **General** tab, ensure that the **Kinetix_Lab** motion group is selected.
3. Select the **Motion Planner** tab and review the parameters. We will keep the default values.
4. From the **Units** tab, change the **Position Units** to **revs** as shown below.



5. On the **Conversion** tab, set the **Positioning Mode** to **Rotary**. The Knife axis will roll-over every revolution.



6. Click on the **Dynamics** tab and enter the parameters below.



7. Click the **Homing** tab and ensure that the homing **Position** is set to **0.0** revs.

8. **Apply** your changes and click **OK** to exit the **Axis Properties** dialog.

Congratulations! You have now configured your Hot Knife virtual axis!

Summarizing our Completed Tasks

In this section of the lab you accomplished the following:

- Created and configured a 2-axis motion system using 1 servo axis (Infeed Belt) and 1 virtual axis (Hot Knife)
- Added the Kinetix 2000 SERCOS drive to your I/O configuration in RSLogix5000
- Assigned the Infeed Belt axis to your Kinetix 2000 drive module

Lab 2: Performing Tests while Online with Controller (approx. 20 min.)

We've created 2 axes of motion with very little effort. It's time to download our project and perform an auto-tuning of our axis.

Downloading the Project to the Controller

1. From the toolbar menu in RSLogix5000, click on **Communications > Who Active** and browse to the controller at your student station.

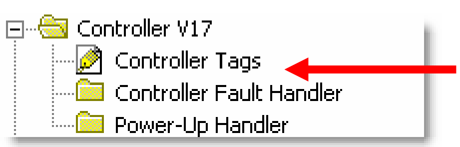
2. Click the **Download** button and go into **Remote Run** mode.

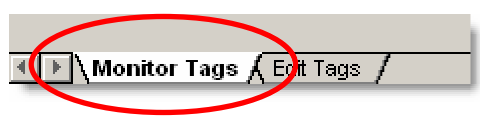
3. Verify that the drive "phases up" as indicated by a **4** on the **7-Segment Display** on the front faceplate of the drive. Additionally, the **Comm** LED should be solid green.

4. Also, verify that all the modules in the I/O configuration are communicating (i.e. no caution signs visible).

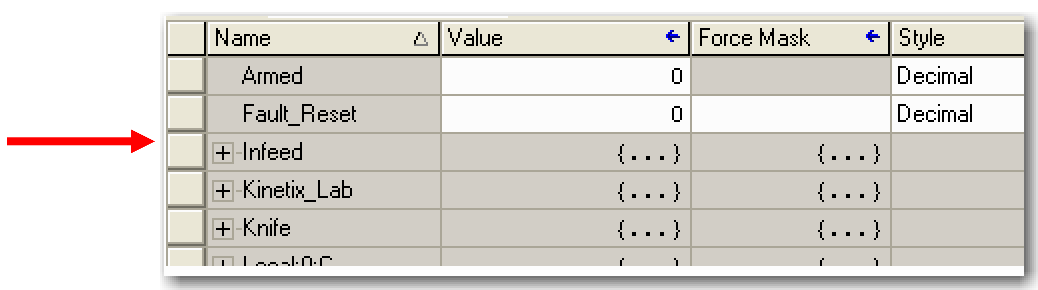
Reviewing the Diagnostic Capabilities of RSLogix5000

1. From the Controller Organizer, double-click on **Controller Tags**. Click on the **Monitor Tags** tab in the lower left corner of the tag database.





2. Locate the **Infeed AXIS_SERVO_DRIVE** tag that you created in the previous section of the lab.



Name	Value	Force Mask	Style
Armed	0		Decimal
Fault_Reset	0		Decimal
+ Infeed	{...}	{...}	
+ Kinetix_Lab	{...}	{...}	
+ Knife	{...}	{...}	

3. Expand the tag to view the data structure.

Most of the diagnostic tags are automatically generated as part of the axis structure when you created the Infeed axis in Logix. This is one of the many benefits of the multi-discipline, integrated controller – you don't need to create code to collect motion controller diagnostics in the controller or HMI.

Let's see how this works by creating a fault condition in the SERCOS ring.

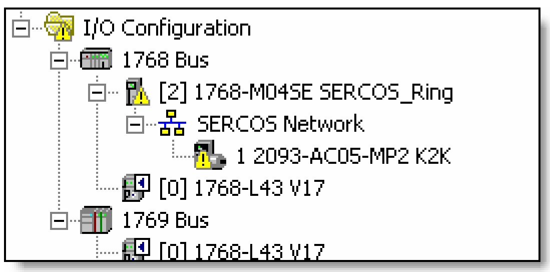
4. In the **Infeed** tag structure, locate the tag called **Infeed,SERCOSRingFault** and note that the current value of the tag is 0, indicating a healthy SERCOS ring.

Infeed.ModuleFaults	16#0000_0000
Infeed.ControlSyncFault	0
Infeed.ModuleSyncFault	0
Infeed.TimerEventFault	0
Infeed.ModuleHardwareFault	0
Infeed.SERCOSRingFault	0

5. On the top left corner of the left-most Kinetix 2000, gently unscrew the receive (**Rx**) side of the SERCOS ring and note that the **Infeed.SERCOSRingFault** tag registers a value of 1 after a few seconds.

   The **Module Status** (Drive) will go solid red and **Comm Status** will go blank on the faceplate of the drive. The drive's 7-segment display will show an **E38** as well.

6. Also, note that the **I/O configuration** registers a fault condition on the **Kinetix 2000 drive** and the **M04SE SERCOS card** as shown below.



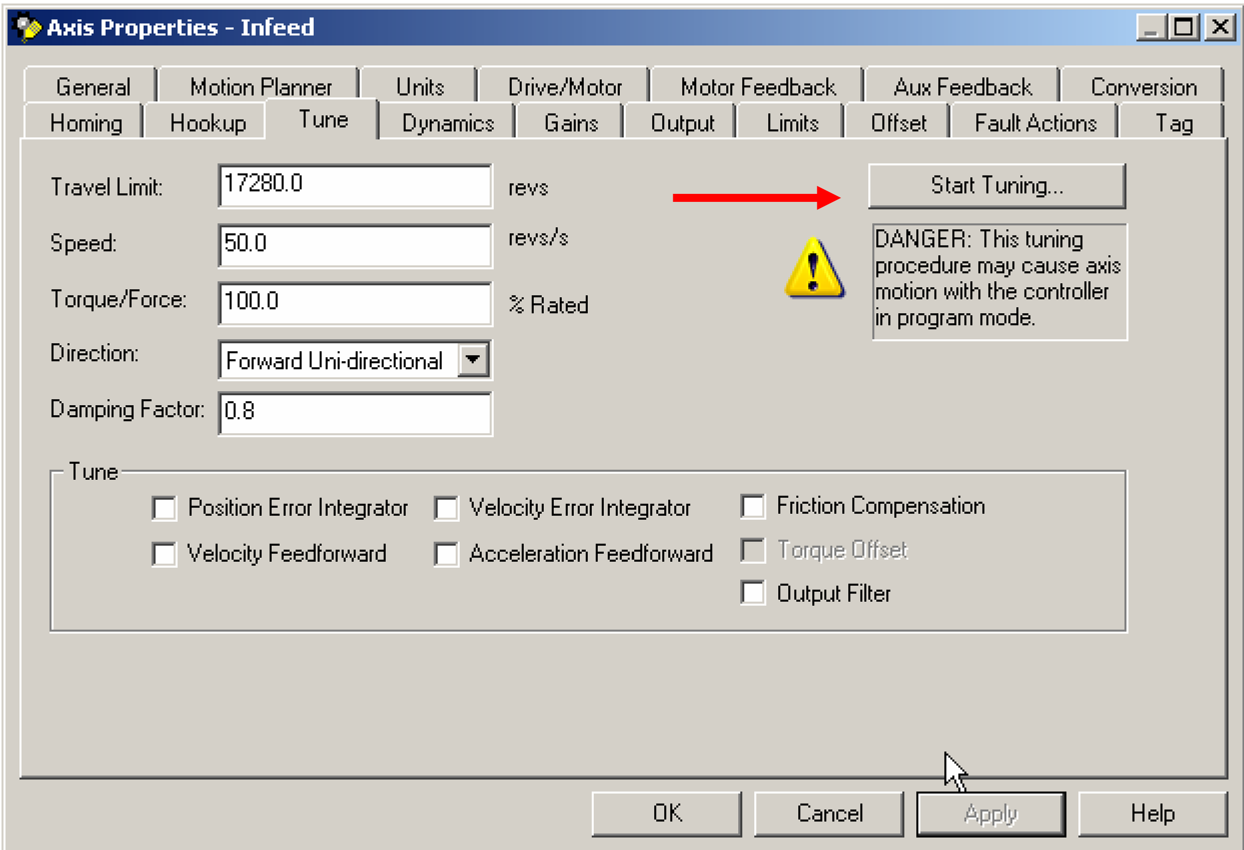
7. Gently screw the **Rx SERCOS** connection back into the Kinetix 2000 drive and verify that the **Infeed.SERCOSRingFault** tag goes back to 0 and the I/O configuration shows a healthy module connection.

We're now ready to Auto-tune our axis.

Auto-tuning the Infeed Belt Axis

The Auto-tuning procedure calculates the Gain values such as Position and Velocity gains as well as other Dynamics such as Acceleration and Deceleration ramps.

1. Double-click the **Infeed** axis to open the **Axis Properties** dialog. Select the **Tune** tab and enter the parameters as shown below and then click **Apply** to accept the changes.



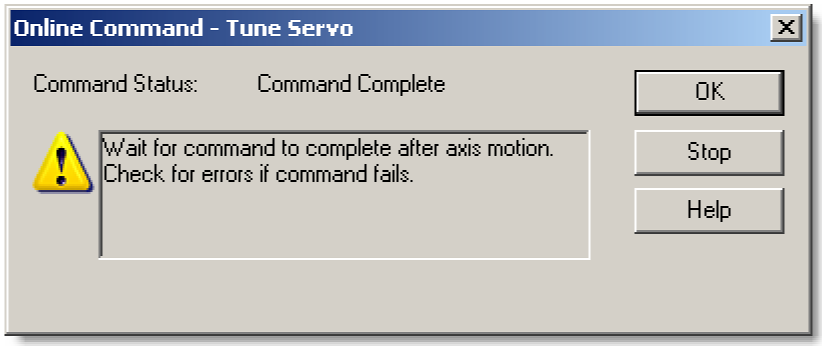
2. Click the **Start Tuning** button to begin the Auto-tuning process.

Note: Make sure the **Hardware Enable switch** on the drive demo box is on.

3. Answer **Yes** to the may cause motion prompt.

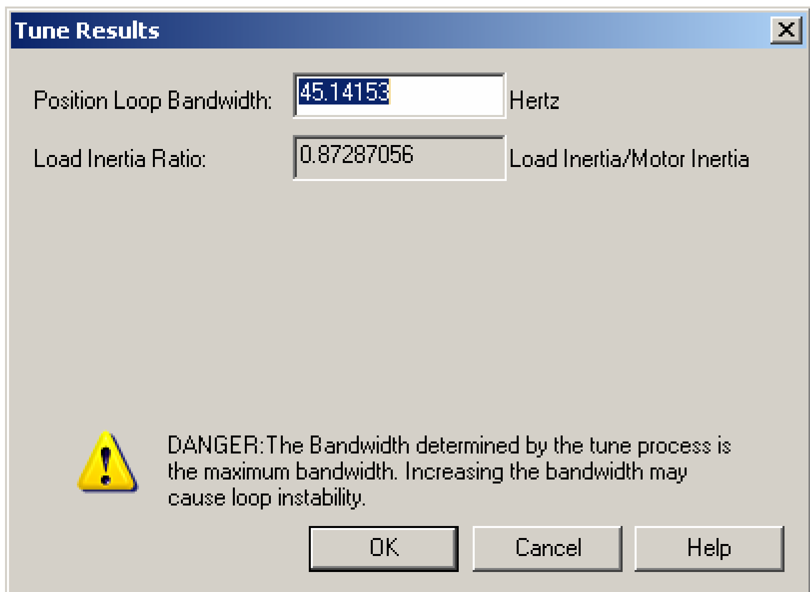
   You should hear the servo enable for as long as it takes it to get to the 50 revs/sec Speed you configured for the process. This is a very quick procedure (less than 1 second).

4. When you see the following prompt, click on **OK** to exit the **Tune Servo** dialog.

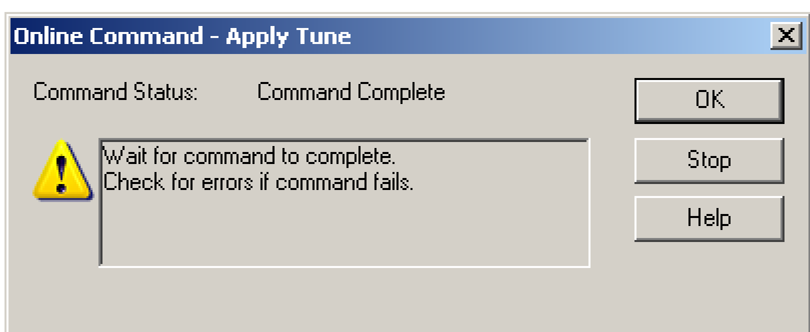


The **Tune Results** dialog box then appears.

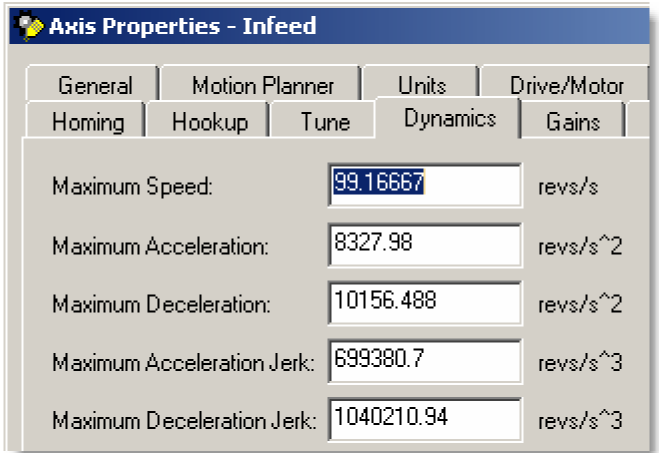
5. Once you have reviewed the values, click **OK** to close the window.

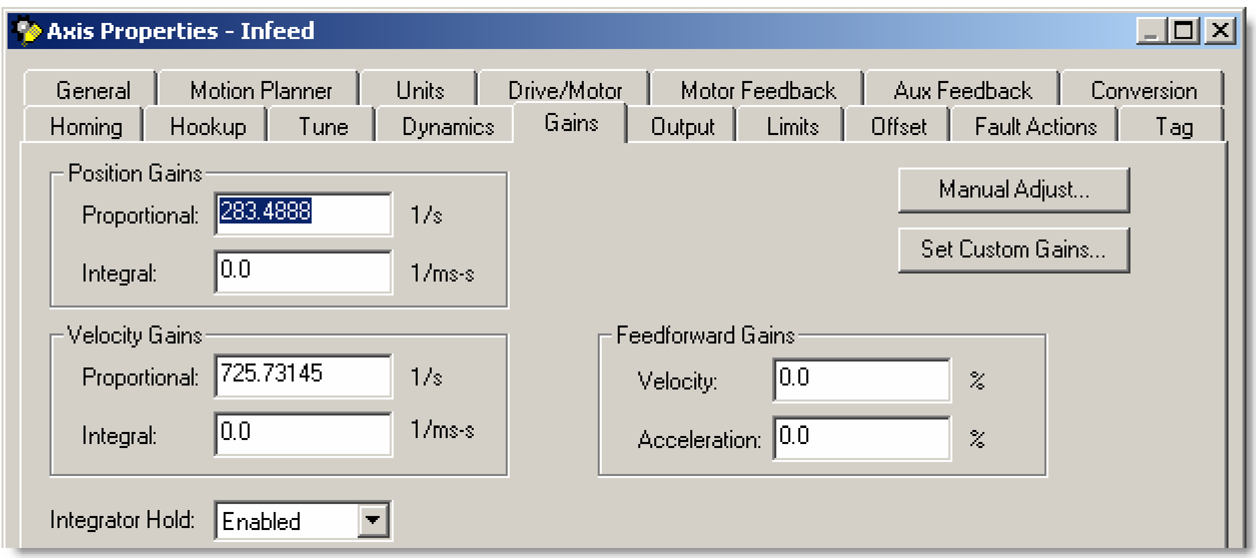


6. Apply the Tuning values by clicking **OK** to the following **Command Complete** dialog.



7. You should now be back to the **Axis Properties** dialog. Take a few moments to review the **Gains** and **Dynamics** tabs. Note that the Gains and Dynamics fields have been populated for you as a result of the Auto-tuning process we just completed.





8. Once you have reviewed these tabs, exit the **Axis Properties** by clicking **OK**.

Congratulations!! You have successfully Auto-tuned the Infeed Belt axis. Now let's learn some basic motion instructions.

Summarizing our Completed Tasks

In this section of the lab you accomplished the following:

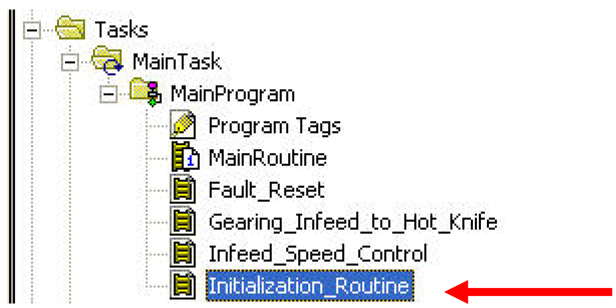
- Downloaded your project to the CompactLogix controller
- Auto-tuned the Infeed Belt axis using RSLogix5000

Lab 3: Basic Motion Instructions (approx. 20 min.)

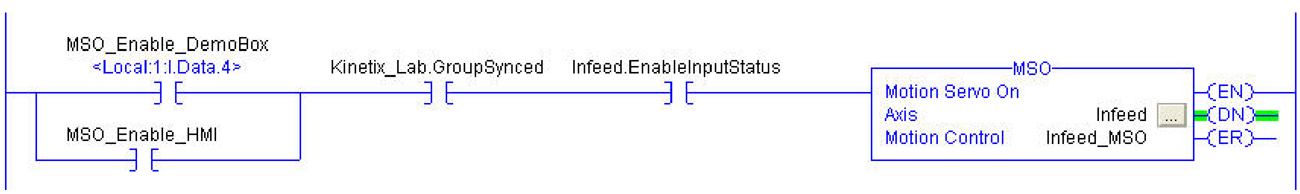
When we talk about Motion, we like to see some things moving. In this section of the lab we'll learn how to make the Infeed Belt axis move. To do this we'll need to enable the drives and synchronize the machine axis.

Enabling and Homing the Axis

1. From the **Controller Organizer**, double-click on the **Initialization_Routine** to open it in the ladder editor.

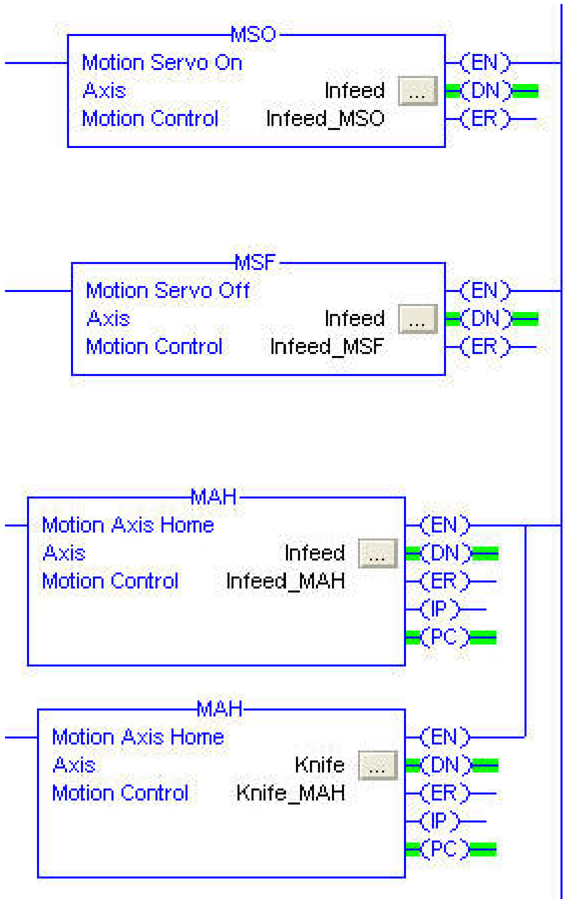


2. Examine **Rung 0** of the **Initialization_Routine** as shown below:



The first thing you should notice is that the **motion instructions** reside in the same programming environment as your other **sequential instructions (i.e. XIC, OTE, TON, etc.)**. This saves so much development time and effort because you don't have to learn and maintain two different programs, coordinate logic with handshaking, or write communication drivers to talk from your sequential controller to your motion controller – everything is programmed and maintained in the Logix controller and RSLogix5000 software!!!

3. Now let's examine the motion instructions in **Rungs 0-2** and learn about the functions of each:



MSO: The Motion Servo On (MSO) instruction Directly activates the drive and enables the configured servo loop.

MSF: The Motion Servo Off (MSF) instruction directly and immediately turns off drive outputs and disables the servo loop on any physical servo axis.

MAH: This instruction initiates the Home Sequence. If the Homing operation is configured for Active, the drive is enabled and the home operation commences as configured.

The three instructions shown above will **Enable/Disable** the Infeed Belt Drive and **Home** the Infeed Belt and Hot Knife axes. Review the descriptions of each instruction above. Note that both the **MSO** and **MAH** Instructions **Enable** the drive. **Enabling** the drive through an **MSO**, however, allows the operator to move the axis prior to homing that axis.

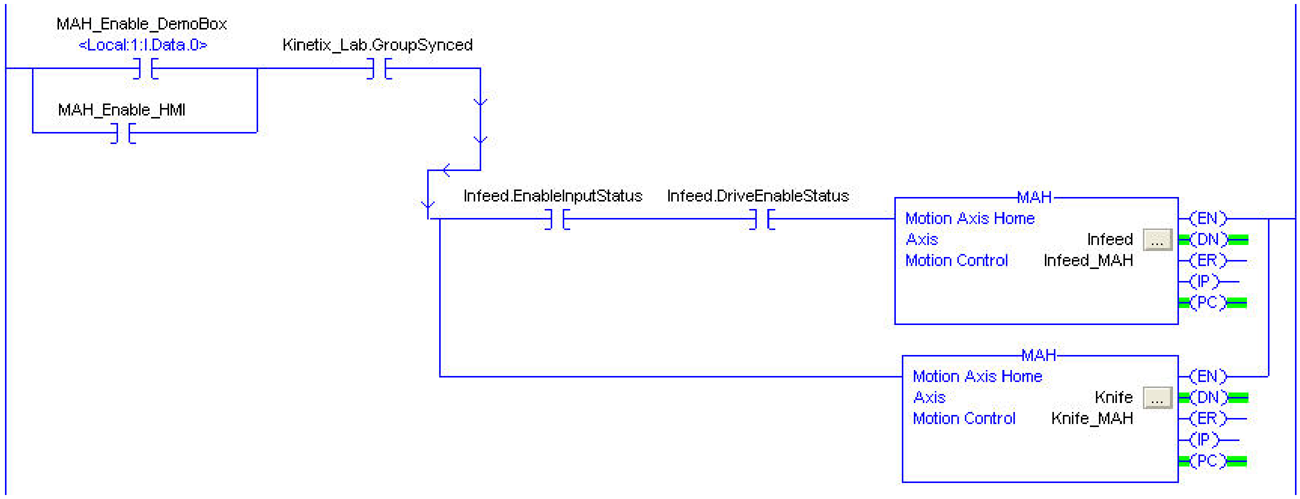
Let's **Enable** the Infeed Belt axis.

4. Locate the **DI4** switch in the CompactLogix demo box and turn it to the **right**. You should hear the servos enable.

Now we're ready to **Home** the axis. The logic that executes this command can be found on **Rung 2** of the **Initialization_Routine**.

5. Press and release the **DI0** pushbutton in the CompactLogix demo box.

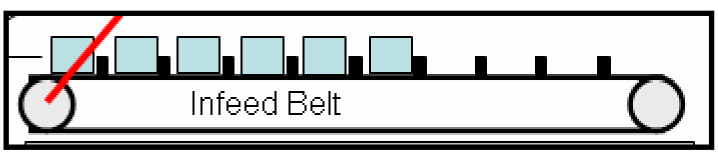
   This energizes the **MAH** motion instructions and homes the axis.



   Once both axes have **Homed**, the LED on the **DO0** pushbutton will illuminate.

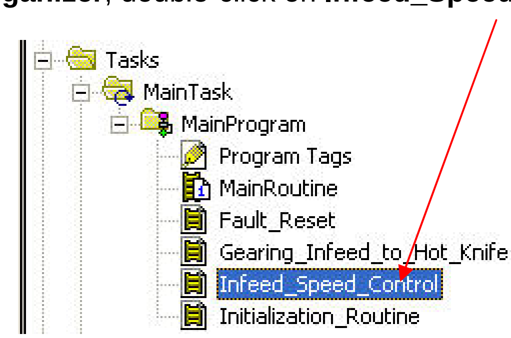
Jogging and Stopping the Infeed Belt Axis

The next step is to program the Infeed Belt axis to move continuously at a given speed and direction to move packages into the Hot Knife area of the machine as shown below:

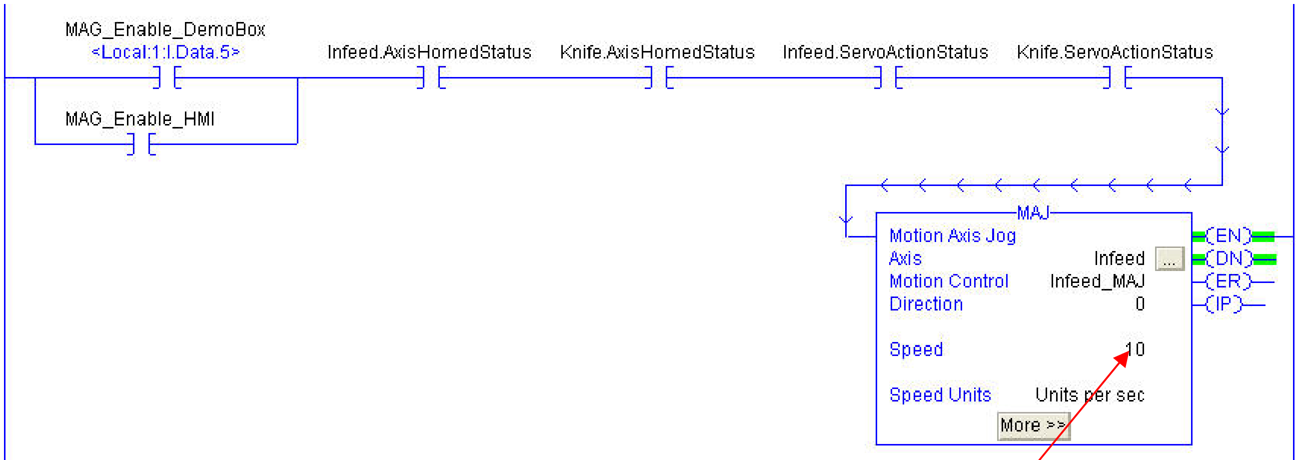


The best Logix Motion Instruction for this task is the **Motion Axis Jog (MAJ)** instruction. This instruction jogs a physical axis the specified direction using a specified speed, acceleration, and deceleration. The **MAJ** instruction will run indefinitely unless we use a **Motion Axis Stop (MAS)** instruction to stop the jog. This instruction will initiate a controlled stop of any motion process without disabling the servo loop. Let's learn how to use both of these instructions to start and stop our Infeed Belt axis.

1. From the **Controller Organizer**, double-click on **Infeed_Speed_Control** routine.

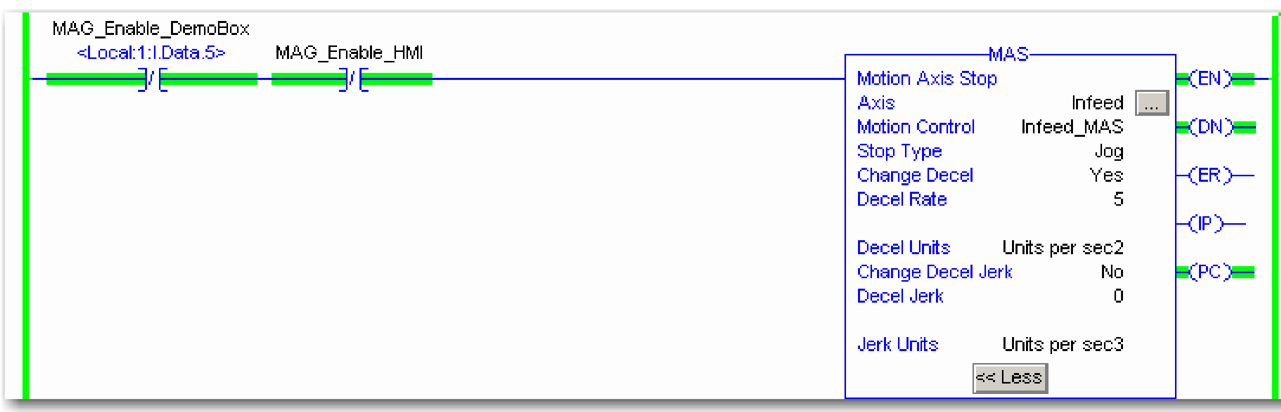


You should see the following programmed in Rung 0:



As you can see, the axis is configured to move continuously (jog) at a speed of **10 revs/sec**. Now we need to be able to stop the axis. Let's write a rung of code to do this.

2. Using the tags that have already been created for you, **insert** a rung beneath **Rung 0** and configure it to appear as shown below (hint: to show all configurable parameters, click the **More>>** button; to show fewer parameters click the **<< Less** button):



Note: The **MAS** instruction can be found in the **Motion Move** instruction tab.

3. After you have created the rung, be sure to accept the program edits you added. You can do this by clicking the **green arrow** (**Finalize All Edits in Program**) and answering **Yes** to the prompt that follows.

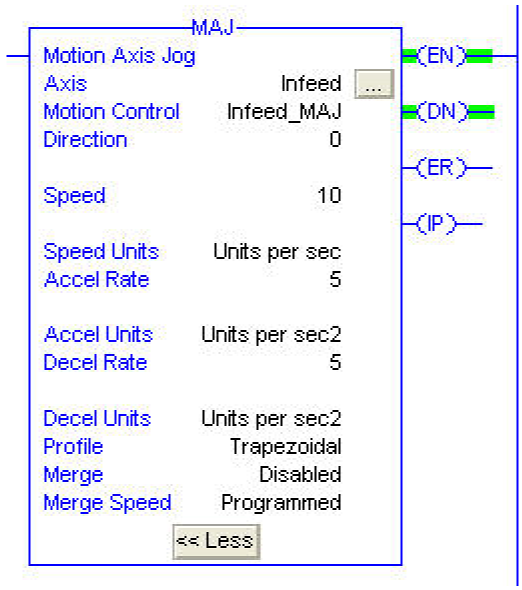
Reviewing and Testing the Logic

Based on the logic, **MAG_Enable_DemoBox (DI5 switch)** or **MAG_Enable_HMI (HMI pushbutton)** must be activated, both Drives must be enabled and both axes must be homed (synchronized) before the **MAJ** instruction can be energized. On the other hand, when the **MAG_Enable_DemoBox (DI5 switch)** and **MAG_Enable_HMI (HMI pushbutton)** inputs are both deactivated, the **MAS** instruction is energized and the Infeed Belt axis is stopped.

1. Enable the drive by turning on **DI4**. If it is already on, toggle it **Off >On**.

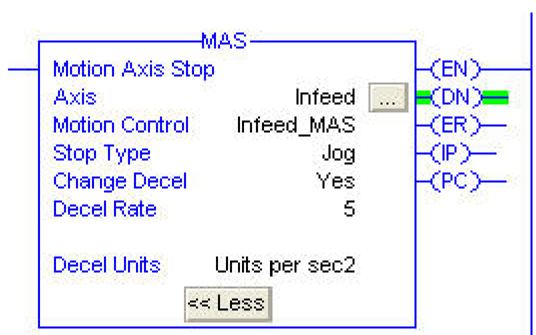
2. Home both axes by pressing **DI0** in the demo box.

3. After all axes are homed (the **DO0** LED is on), turn the Infeed Belt axis on by turning the **DI5** switch to the **right**. The Infeed Belt axis will accelerate at the **Accel Rate (5 in/sec^2)** and then hold a constant **Speed** of **10 in/sec** as configured in the **MAJ** instruction as shown below:



4. Now turn the Infeed Belt axis off by turning the **DI5** switch to the **left**.

   The axis will now decelerate at the **Decel Rate** you configured in the **MAS** instruction (5 in/sec^2) as shown below:



Excellent! Our axis is successfully jogging and stopping as we expect, but now we need to vary its speed according to the package feed-rates. Let's examine how this can be accomplished.

Summarizing our Completed Tasks

In this section of the lab we got things MOVING by doing the following:

- Enabling the Infeed Belt axis and homing both axes through instructions available to us in the ladder editor of RSLogix5000
- Jogging and Stopping the Infeed Belt axis through ladder code through instructions available to us in the ladder editor of RSLogix5000

Lab 4: Using Motion Direct Commands & Varying the Axis Speed (approx. 20 min.)

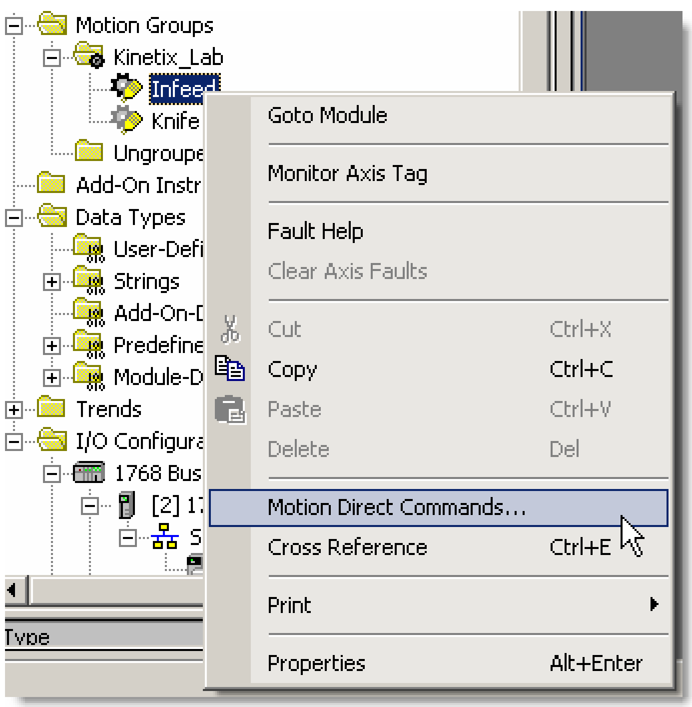
The instruction required to vary the speed of an axis is the **Motion Change Dynamics (MCD)** instruction. The **MCD** instruction changes the speed, acceleration and deceleration of trapezoidal profile moves on the fly. We'll show how this can be accomplished using two different methods: **Motion Direct Commands** and **Ladder programming**.

Varying the Infeed Belt Axis Speed Using a Motion Direct Command

A **Motion Direct Command** is a motion command sent directly to the controller from the software as a result of a user action. These commands execute without being initiated by a user program (i.e. ladder code). You must be **online** with your controller to execute **Motion Direct Commands**. Let's see how these work using the Infeed Belt axis as our test case.

1. Start the Infeed Belt axis jog again by turning the **DI5** switch to the **right**.

2. From the **Controller Organizer**, right-click on the **Infeed** axis and choose **Motion Direct Commands**.

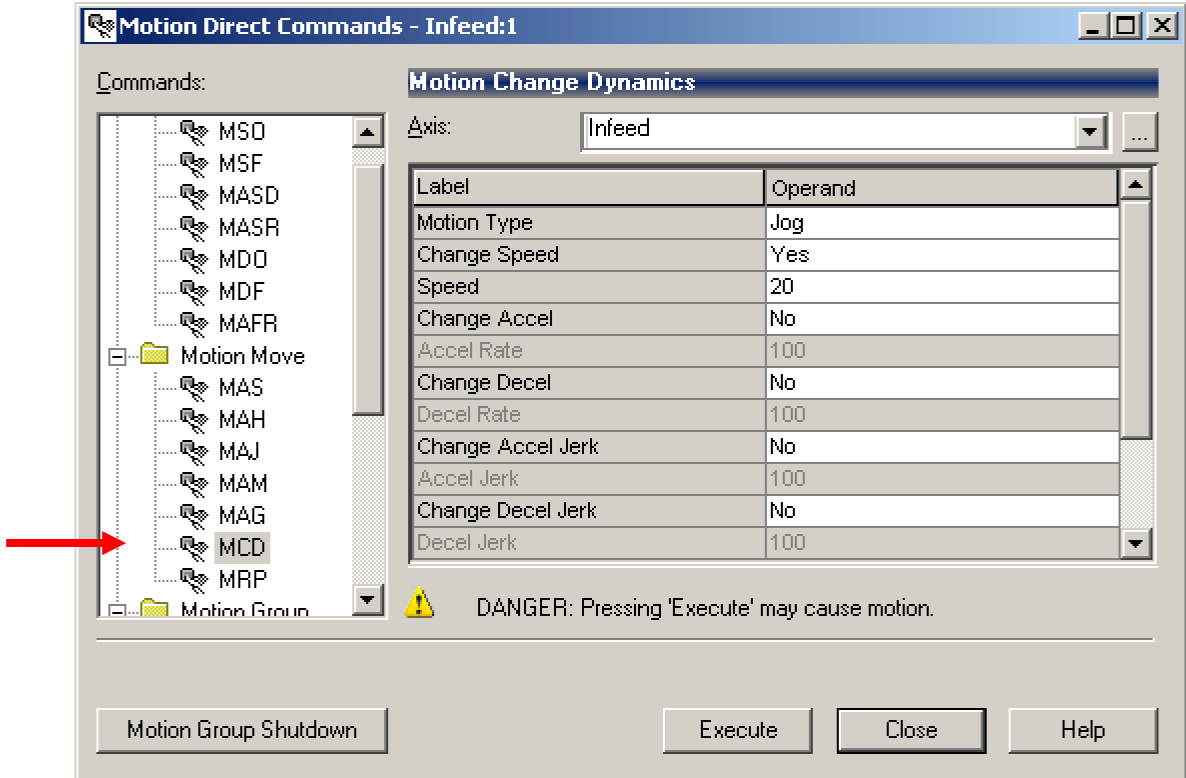


This opens the **Motion Direct Commands** dialog box.

3. Take a moment to look through all the commands available to you.

4. Find and click on the **MCD** instruction so that its configuration window appears.

5. Set **Change Speed** to **Yes** and set the **Speed** of the axis to **20 inches/sec**.



6. Once you have verified the configuration, click the **Execute** button.

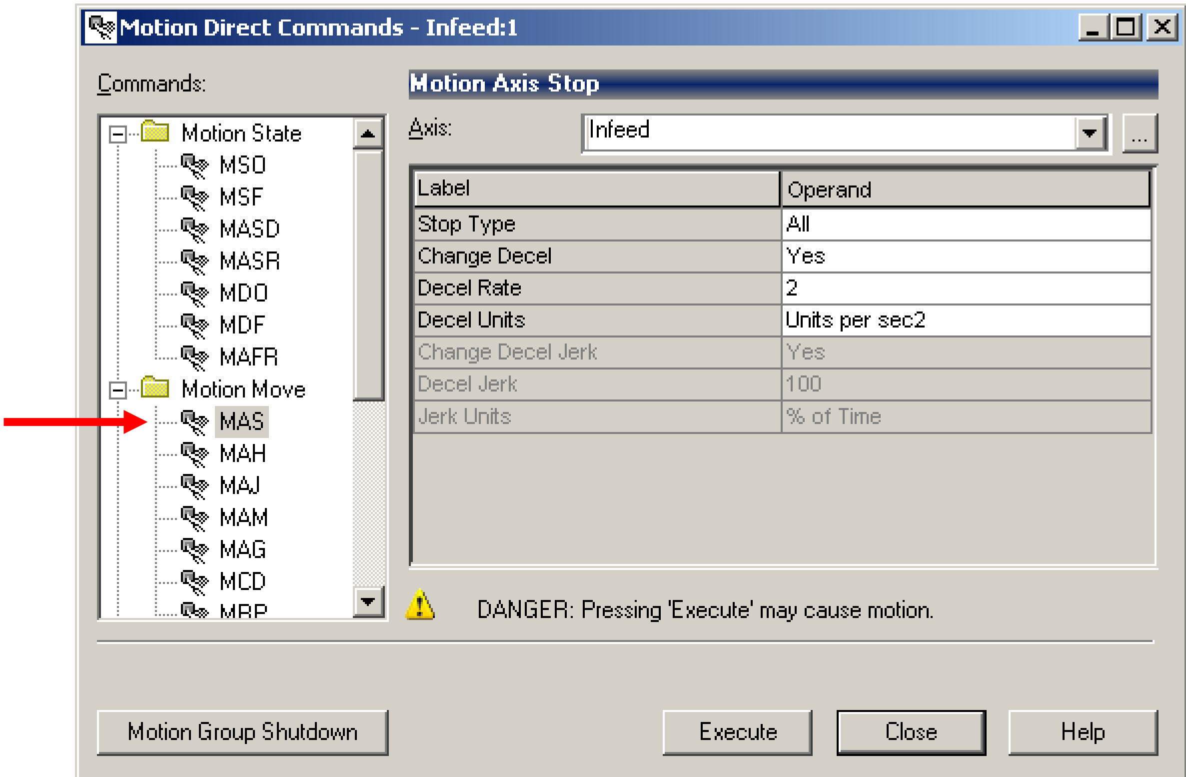
   You should see a clear increase in the speed of rotation on the Infeed Belt axis. Remember, we initially had configured the axis to jog at 10 inches/sec. Now it's rotating at twice that speed and we didn't even write any ladder code to execute this change – **everything was done on the fly using Motion Direct Commands!**

Now, let's stop the Infeed Belt axis rotation by using the **Motion Axis Stop (MAS)** Motion Direct Command.

Stopping the Infeed Belt Axis Using a Motion Direct Command

1. From the **Motion Direct Commands** dialog box, click on the **Motion Axis Stop (MAS)** instruction in the **Motion Move** folder.

2. Configure the instruction as shown below and then click **Execute**. The Infeed Belt axis will now slow at a rate of 2 inches/sec^2.



3. When the axis has slowed to a stop, click the **Close** button to exit the **Motion Direct Commands** dialog box.

4. Turn the Infeed Belt off by toggling the **DI5** switch to the **off (left)** position.

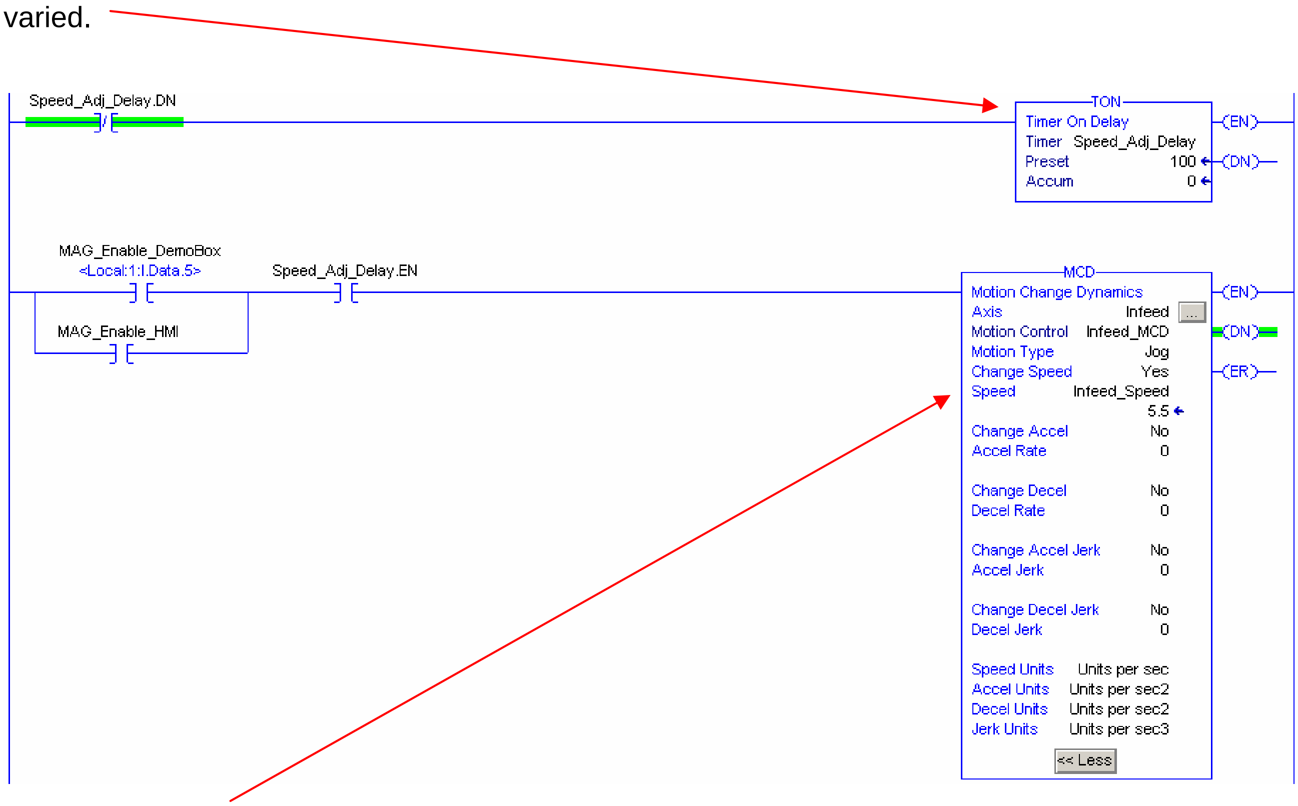
5. Disable the servo by toggling the **DI4** switch off.

Varying the Infeed Belt Axis Speed Programmatically

We can also use the **Motion Change Dynamics (MCD)** instruction programmatically to change the speed of our axis. This involves writing some code to execute the logic. We'll use Ladder code to demonstrate this functionality. We're going to use the **AI0** potentiometer to vary the speed of the Infeed Belt axis. Take a moment to locate this dial in the demo box.

1. From the **Controller Organizer**, open the **Infeed_Speed_Control** routine and add the following rungs of code below rung 2, using the tags that have already been created for you. After you have created the rungs, be sure to **finalize** the program edits you added.

   The **Timer** is required to pulse the **MCD** with the new speed values as the potentiometer is varied.



Note that the **Infeed_Speed** tag has been created for you. If you examine rung 2, you will notice that the tag, **Infeed_Speed_Actual,** is an alias for the **AI0** potentiometer in the demo box. Since the value obtained from **AI0** is not scaled properly for setting the jog speed directly, rung 2 scales it to a 0-10 revs/s value and stores this scaled value in the **Infeed_Speed** tag. It also makes sure that that the **Infeed_Speed** can never be 0 revs/s, ensuring that the **MAJ** does not stop executing due to the **MCD** applying a 0 revs/s jog speed.

Therefore, when you turn the potentiometer, the speed of the axis will increase or decrease accordingly. Let's test our logic.

2. **Save** your program and answer **Yes** to the upload tags prompt. Ensure your controller is in **Remote Run** mode.

3. Ensure that your drive is **Enabled (DI4)** and all axes are **Homed (DI0).**

4. Turn the **Infeed Belt** on **(DI5)** and rotate the **AI0** potentiometer.

The speed of the axis will change based on the input from the potentiometer. This is a simple exercise, but very powerful. Our axis speed is now a variable capable of being accessed and changed from a visualization product, from a recipe, or from a production scheduling system via one of Rockwell Automation's network solutions.

5. Turn the Infeed Belt off by toggling the **DI5** switch to the **off (left)** position.

6. Disable the servo by toggling the **DI4** switch to the **off (left)** position.

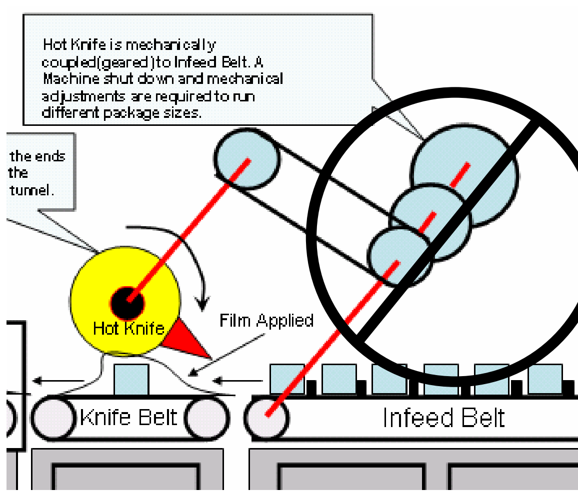
Summarizing our Completed Tasks

In this section of the lab you accomplished the following:

- Learned how to vary the speed of an axis through 2 different methods: using Motion Direct Commands and using motion instructions in the ladder editor of RSLogix5000
- Learned how Motion Direct Commands can execute instructions such as Motion Change Dynamics (MCD) and Motion Axis Stop (MAS) on the fly
- Used ladder code to execute the MCD and MAS instructions

Lab 5: Using Trends to Demonstrate Electronic Gearing (approx. 15 min.)

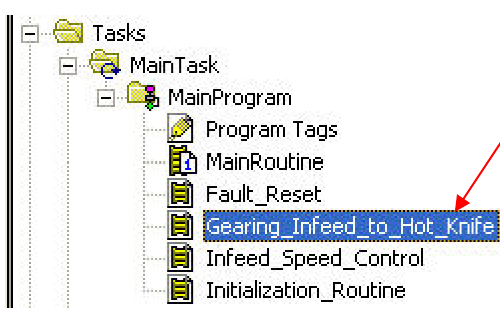
You have decided to take advantage of the Electronic Gearing feature available in RSLogix5000. This will eliminate the pulley system and the associated cost of tearing down the machine to make mechanical pulley adjustments when smaller packages are processed through the machine.



The **Motion Axis Gear (MAG)** instruction enables electronic gearing between two axes at a specified ratio. On your customer's machine, the **Infeed Belt** axis is the **Master** and the **Knife** axis is the **Slave**. Both are programmed in revs/sec. Initially, the largest package will be run through the machine and a 1:1 ratio will be used. The **Knife** will match the speed of the **Infeed Belt** (revs/sec) exactly. Let's demonstrate this using the trending feature available in RSLogix5000.

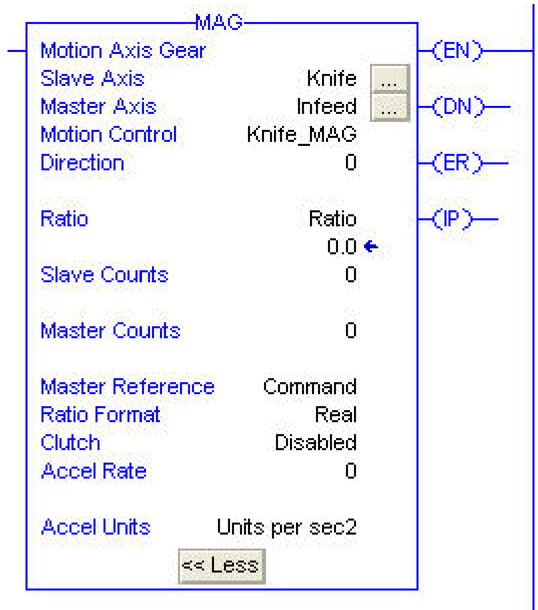
Viewing the Gearing Trend with a 1:1 Ratio

1. From the **Controller Organizer**, double-click on the **Gearing_Infeed_to_Hot_Knife** routine to open it in the Ladder Editor.



Notice that there are only 2 rungs in this routine: one to enable gearing and one to disable it. Let's take a look at the **Motion Axis Gear (MAG)** instruction.

2. Expand the **MAG** instruction so that you can see all the configurable parameters as shown below.



Notice that the **Infeed Belt** axis is considered the **Master** and the **Knife** axis the **Slave**.

3. Change the gearing **Ratio** to 1.0. This provides a 1:1 gearing ratio.

4. If not online, **Download** the project to the controller and ensure that the controller is in **Remote Run** mode.

5. **Enable** the drive by turning the **DI4** switch to the **right**.

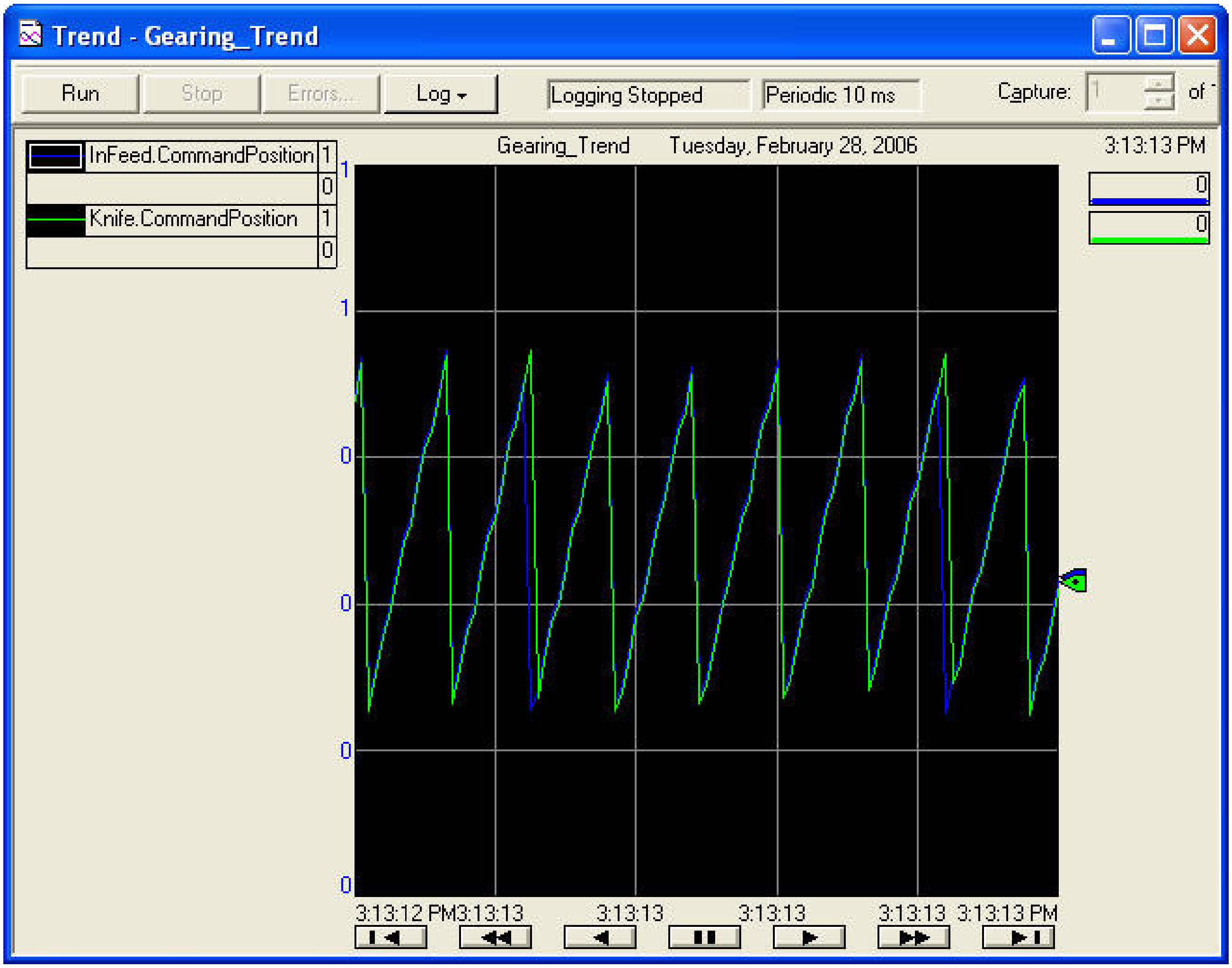
6. **Home** all axes by pushing the **DI0** pushbutton.

7. Turn the **DI5** switch to the **right**. This turns the **Infeed Belt** axis on and also turns on **Gearing** (as programmed in your logic).

8. From the **Controller Organizer**, double-click on the **Gearing_Trend**.

9. Click the **Run** button on the trend to put it in motion.

   Notice that the commanded position for both the Knife and Infeed Belt axes are tracking very closely. This means that the Knife is synchronized to the Infeed Belt axis and makes 1 revolution for every 1 revolution of the Infeed Belt motor.



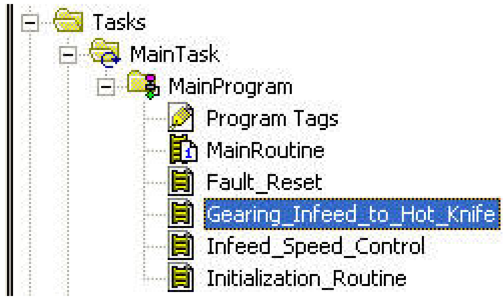
10. Click the **Stop** button and close the **Gearing_Trend**.

11. Turn the **Infeed Belt** axis **off** by turning the **DI5** switch to the **left**.

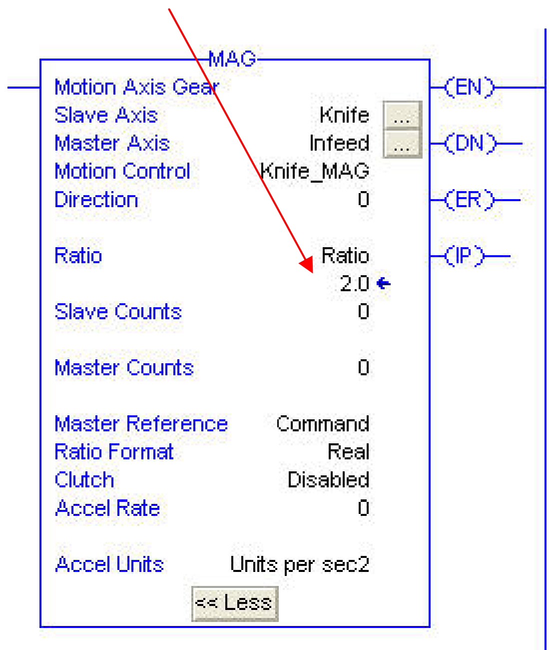
Viewing the Gearing Trend with a 2:1 Ratio

In this section of the lab, we'll re-configure the **Motion Axis Gear (MAG)** instruction to have a gear ratio of 2.

1. From the **Controller Organizer**, double-click on the **Gearing_Infeed_to_Hot_Knife** routine to open it in the Ladder Editor.



2. Change the **MAG** gearing **Ratio** to **2.0**.



   Note that there are many ways by which you can change the gear ratio. **Ratio** is simply a tag that was created and resides in the controller memory. It can be manipulated in the **MAG** instruction, in the tag monitor, etc. It can also easily be modified remotely through an HMI or higher level enterprise system.

3. Turn the **Infeed Belt** axis on by turning the **DI5** switch to the **right**.

4. From the **Controller Organizer**, double-click on the **Gearing_Trend** and once again put it in **Run** mode.

   Notice that the **Knife** is still synchronized to the **Infeed Belt** but makes two revolutions for every revolution of the **Infeed Belt** motor.

5. Click the **Stop** button and close the **Gearing_Trend**.

6. Turn the **Infeed Belt** off by toggling the **DI5** switch to the **off (left)** position.

7. Disable the servos by toggling the **DI4** switch **off**.

8. Minimize (DO NOT close) your session of RSLogix5000.

Gearing axes and trending data are easy using RSLogix5000!

Summarizing our Completed Tasks

In this section of the lab you accomplished the following:

- Learned how to alter the gearing ratio of the Motion Axis Gear (MAG) instruction
- Used the trend feature of RSLogix5000 to get a graphical view of changes made to the gearing ratio

Lab 7: Duplicating and Modifying an Axis of Motion (approx. 10 min.)

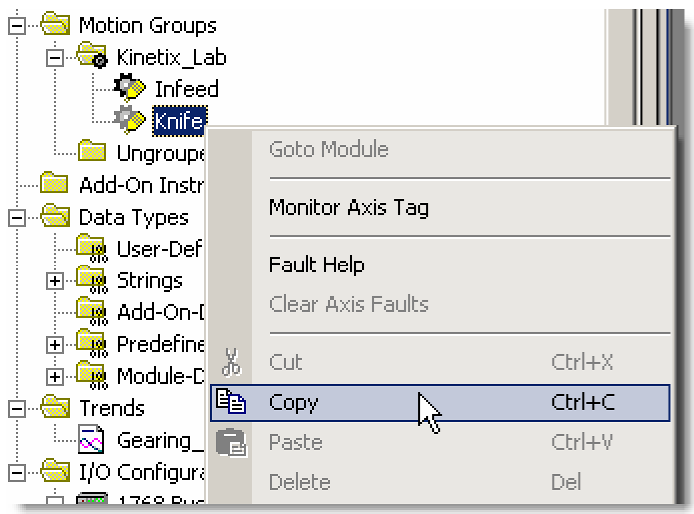
Adding the Pick and Place Axis to the Project

Previously, you successfully configured both the Infeed Belt axis and Hot Knife axis. It's so easy to do with the convenient Axis Wizards provided through RSLogix5000!! Remember that one of the demands of our customer was that they needed an expandable system capable of handling additional axes for future Pick and Place units.

Since we don't have another physical drive and motor available to us at this point, let's go ahead and create another virtual axis. Great news – we've already created the Hot Knife as a virtual axis so we can simply copy that axis and rename it as the Pick and Place axis. Let's do that now.

1. Go **Offline** with the controller.

2. From the **Controller Organizer**, right click on the **Knife** axis and then choose **Copy**.



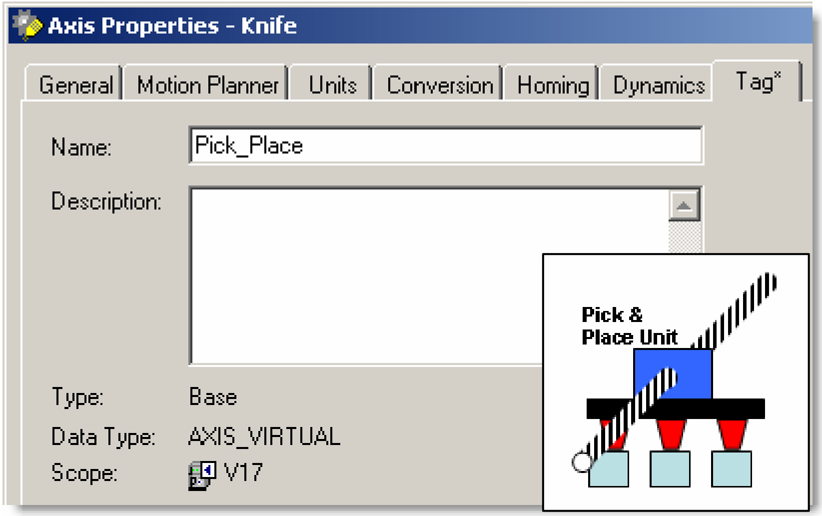
3. Right-click on the **Kinetix_Lab** Motion Group and then choose **Paste** so that your Motion Group folder appears as shown below:

Notice that the Knife axis has been duplicated as Knife1. This axis duplication capability can really save a lot of development time!! Now you can rename the axis if you so choose. Let's go ahead and do this since we know this axis will be used for the Pick and Place axis.

4. Right-click on the **Knife1** axis and choose **Properties**.

The Axis Properties dialog appears.

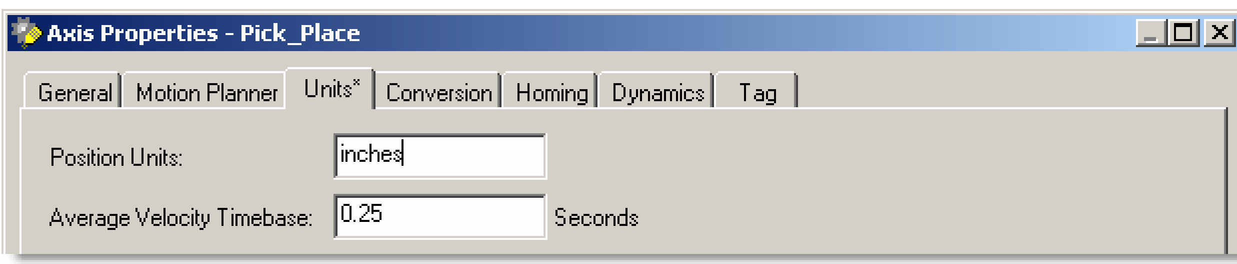
5. Click on the **Tag** tab and rename the axis so it appears as shown below.



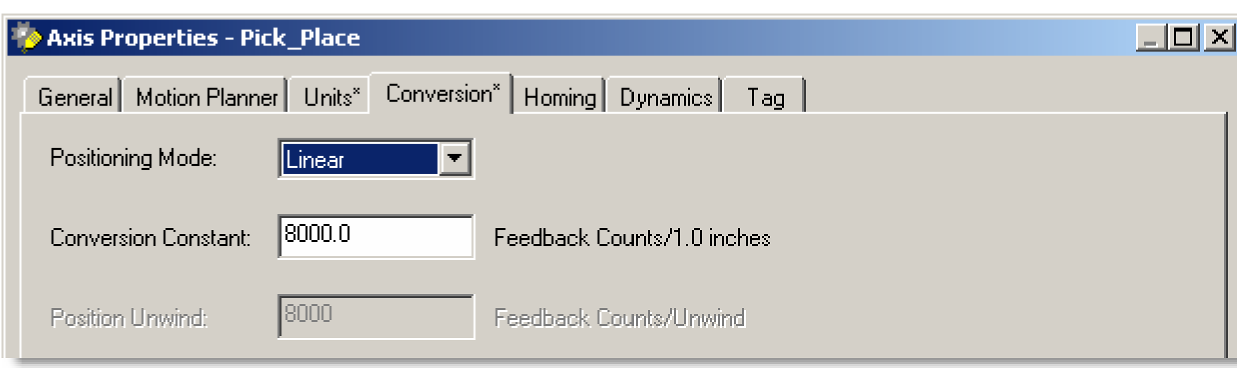
6. Click **Apply** to accept your changes.

Now all we need to do is modify this axis with the appropriate configuration for our application. The Pick and Place axis is going to be linear instead of rotary like the Infeed Belt and Hot Knife axes. Let's change the configuration to accommodate this type of functionality. It's a very simple modification!

7. Click on the **Units** tab to change the Position Units to inches instead of revs as shown below.



8. Click on the **Conversion** tab and choose **Linear** from the Positioning Mode pull-down menu. Your configuration should appear as shown below.



9. Modification of this axis is complete. Go ahead and accept your changes by clicking the **Apply** button, then close the dialog window by clicking **OK**.

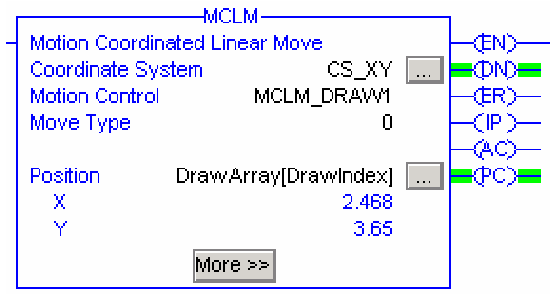
Summarizing our Completed Tasks

In this section of the lab you accomplished the following:

- Learned how easy and time efficient using Kinetix Integrated Motion is by quickly duplicating and modifying an axis of motion
- Learned how using Kinetix Integrated Motion can greatly reduce my program development and maintenance

Lab 8: Using Virtual Axes to Demonstrate Linear Interpolation (approx. 20 min.)

The **Motion Coordinated Linear Move (MCLM)** instruction performs a single or multi-dimensional linear coordinated move using up to three (3) axes statically coupled to the coordinate system as primary axes in a Cartesian coordinate system.



The **Coordinate System** operand specifies the set of motion axes that define the dimensions of a Cartesian coordinate system. The coordinate system supports up to three (3) primary axes. Only those axes configured as primary axes are included in the coordinate velocity calculations.

Understanding the Coordinate System

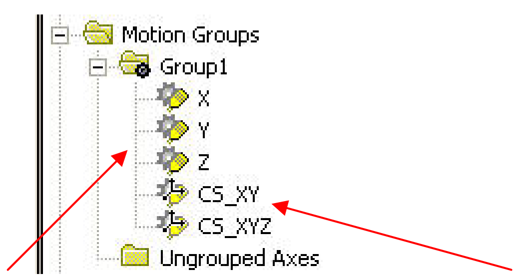
In this section of the lab, we're going to see the **MCLM** instruction in action through the use of 3 Virtual axes and 2 Coordinate Systems.

1. Exit the **Intro_to_Kinetix_Integrated_Motion.ACD** project you've been working on in RSLogix5000.

2. From the computer desktop, double-click on the **Working Folder.** 

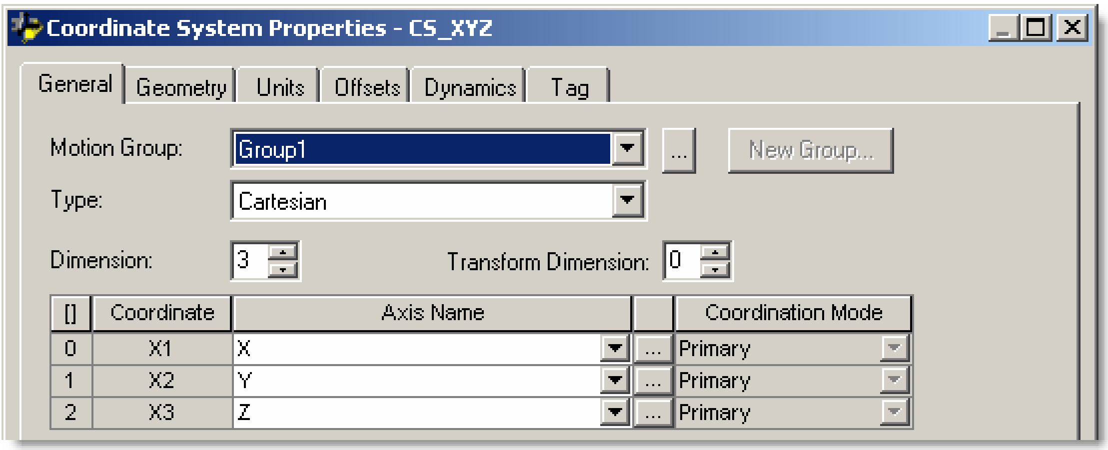
3. Double-click the **ABLogo.ACD** file to launch the project in RSLogix5000.

4. In the **Controller Organizer**, locate the **Motion Groups** folder as shown below:



Notice that there are **3 Virtual Axes** (X, Y, and Z) and **2 Coordinate Systems** (CS_XY and CS_XYZ) configured. Remember, the Coordinate System specifies the set of motion axes that define the dimensions of a Cartesian coordinate system and supports up to three (3) primary axes.

5. From the **Controller Organizer**, right-click on the **CS_XYZ** coordinate system and choose **Properties**. The following dialog box appears.

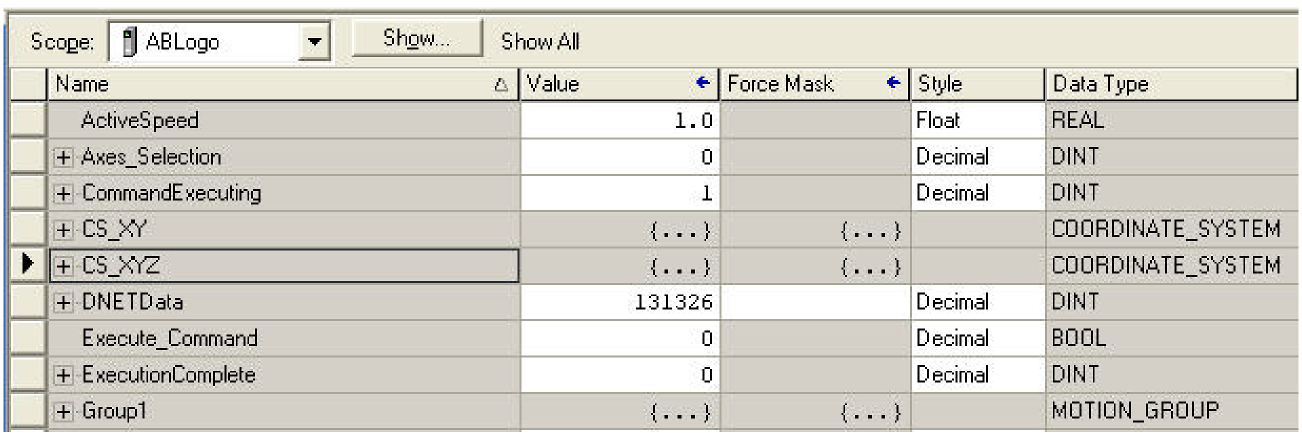


Notice that this Coordinate System has been configured to coordinate all three virtual axes: X, Y, and Z.

6. When you have finished reviewing the configuration click **Cancel** to exit the **Coordinate System Properties** dialog.

7. Again, right click on the **CS_XYZ.** Then choose **Monitor Coordinate System Tag**.

   This opens the tag monitor as shown below:

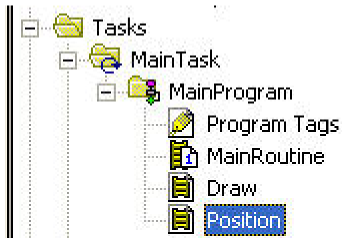


8. Expand the **CS_XYZ** tag to review the parameters associated with this axis structure.

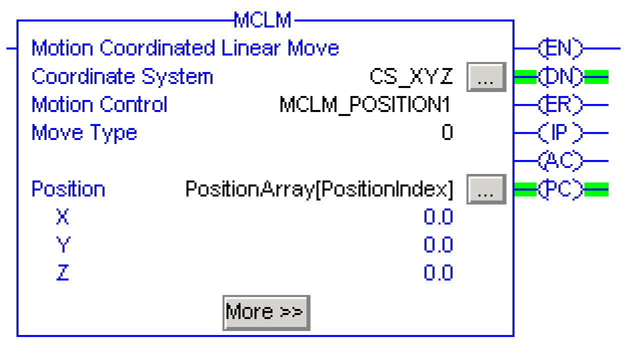
Now let's see how this coordinate system is used in a **Motion Coordinated Linear Move (MCLM)** instruction.

Reviewing the MCLM Instruction & Downloading the Project to the Controller

1. From the **Controller Organizer**, double-click on the **Position** routine to open it in the ladder editor.



2. Navigate to **Rung 1** and locate the **MCLM** instruction.

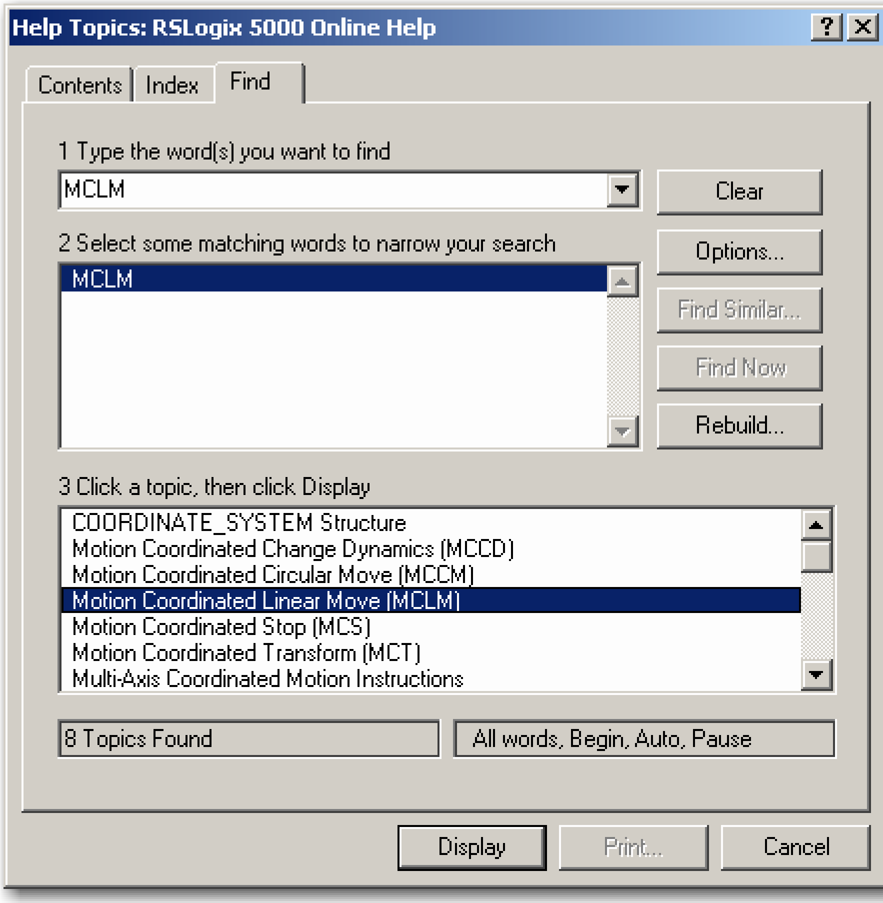


3. Expand the instruction by clicking the **More>>** button.

4. From the toolbar menu choose **Help > Contents**.

5. Enter **MCLM** in the Search field; this will retrieve topics relating to the MCLM instruction.

6. Click on the **Motion Coordinated Linear Move (MCLM)** as shown below, then click on **Display**.



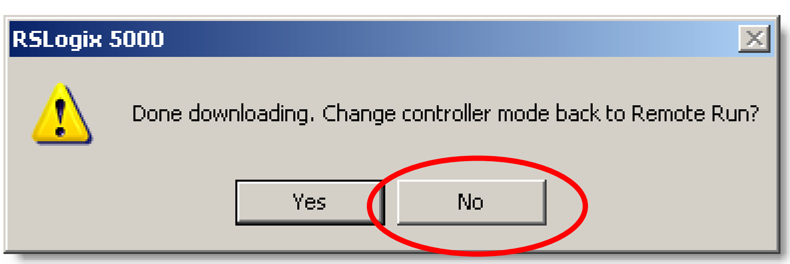
This opens RSLogix5000 Help for this motion instruction.

7. Take a few moments to review the configurable parameters available in the instruction and then exit help.

Let's download our project and see what this instruction can do.

8. From the toolbar menu, select **Communications > Who Active** and download the project to the **L43** controller at your student station.

9. If prompted with the following dialog box, click on **No**.



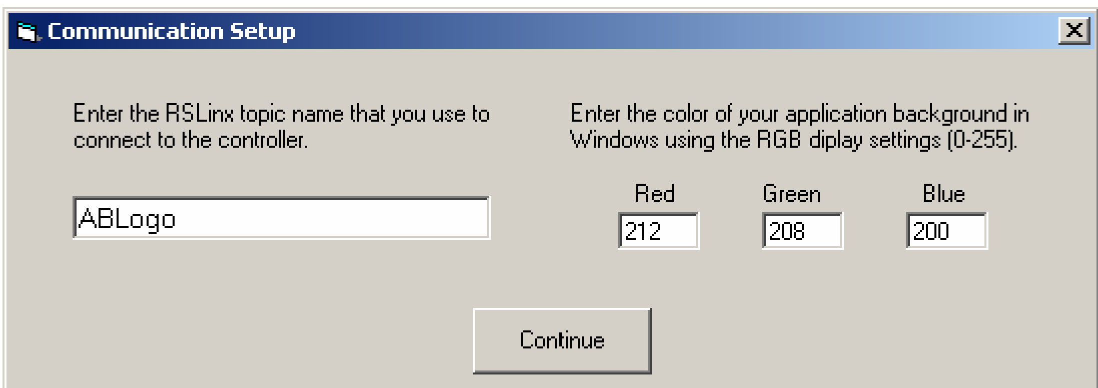
Launching the MCLM Demo

We have now successfully downloaded a project that will demonstrate the MCLM motion instruction to the controller in slot 0 of our CompactLogix system. To demonstrate the functionality of the MCLM motion instruction, we've created a Visual Basic graphical interface display for you to view. This simulates what you may see in an operator interface such as RSView Studio.

1. From the computer desktop, double-click on the **Working Folder**. 

2. Double-click on the **Graph.exe** file.

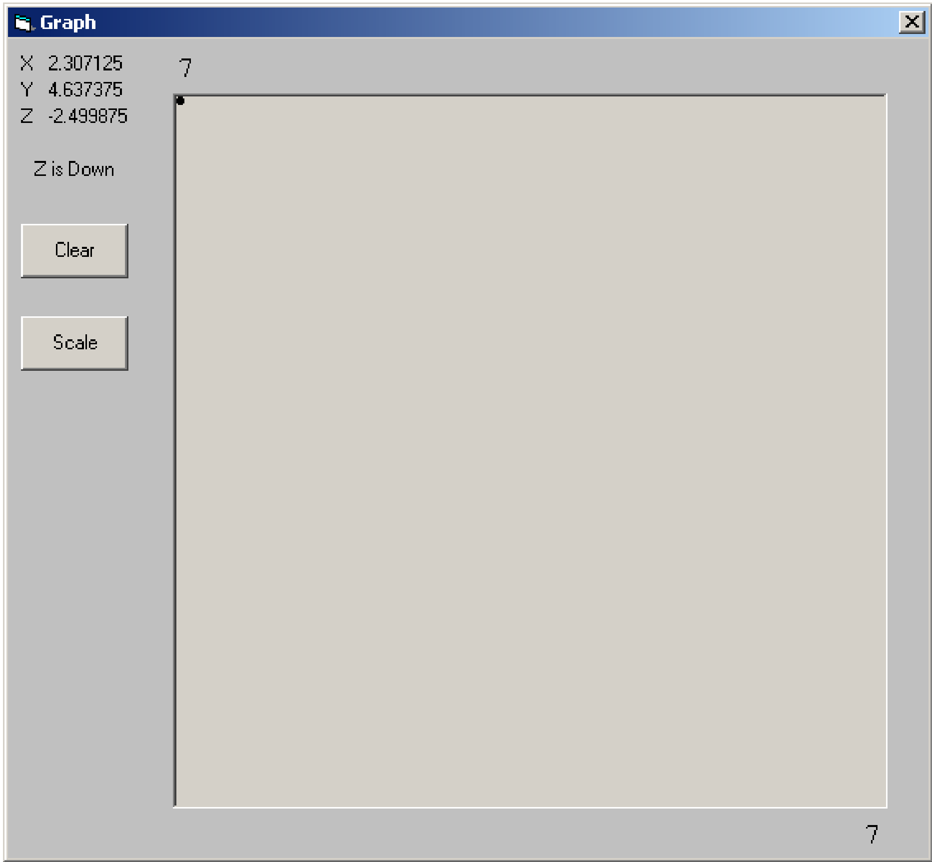
3. When the following dialog box appears, enter **ABLogo** as your RSLinx topic name as shown below.



The RSLinx topic was created for you in the interest of time. This communication setup simply points this executable to the source of the data (the L43 processor in slot 0 of the system).

4. Click the **Continue** button when you have verified the topic name.

   The following graphic interface will launch.



5. To start the 3-axis graphic motion, toggle the key switch on the L43 controller in slot 0 to **Run** or enter **Run mode** from RSLogix5000.

You are now seeing the MCLM instruction in action!!!

6. When the graphic has completed, **exit** out of the interface by clicking the **X** in the upper right hand corner of the executable.

Summarizing our Completed Tasks

In this section of the lab you learned a great new feature of Kinetix Integrated Motion:

- Learned what the Motion Coordinated Linear Move (MCLM) instruction does
- Learned about some of the instruction's parameters by reviewing the ladder code
- Viewed some of the axis parameters
- Saw the MCLM instruction in action through a graphical demonstration