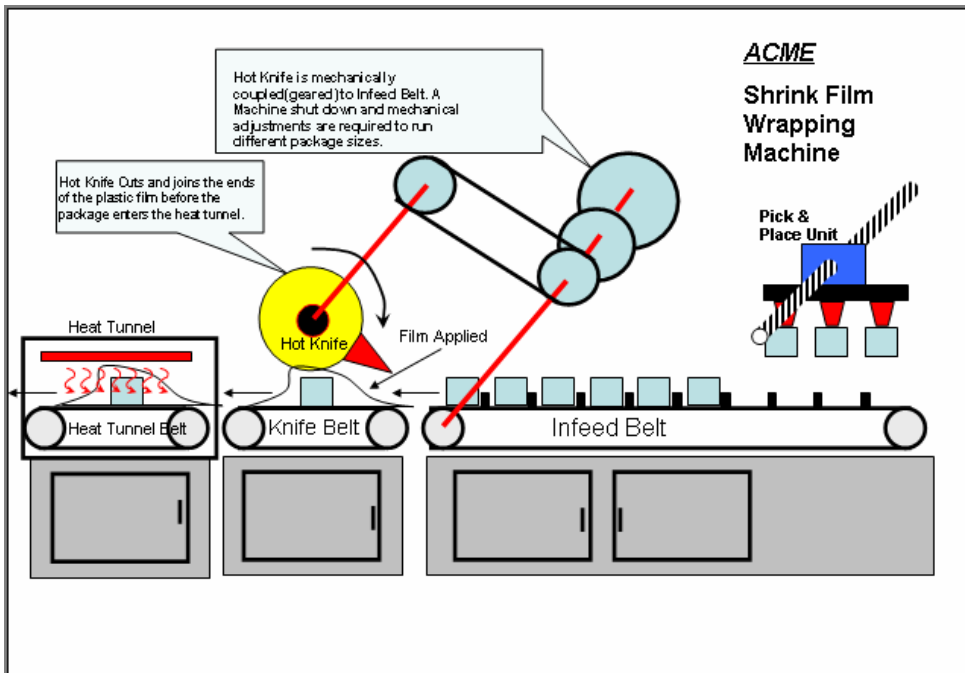
Lab 3, Logix Basic Motion Instructions

One of your customers, Premier Packaging has experienced increased demand for their packaging services .To meet demand; they 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 the Infeed belt. The infeed belt 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 leading to costly set up charges and reduced production efficiencies.

The Existing Control System consists of the following:

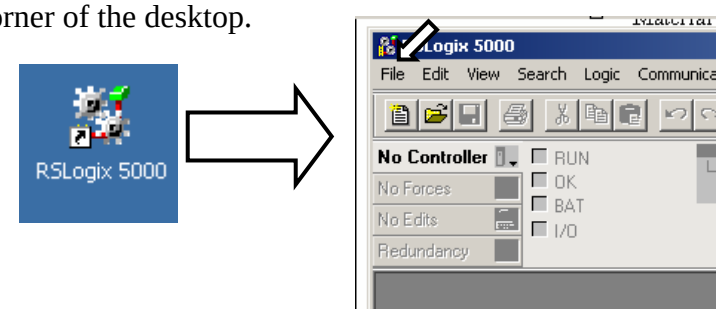
- **DC Motor & Drive** (Coupled to Infeed Belt). Speed is controlled through a potentiometer. All other speed synchronization is done mechanically.
- **PLC** to control the Sequential Logic of the Machine.
- Separate **Temperature Controllers** on the Hot Knife and Heat Tunnel.

The customer is requesting a control system that will provide the following benefits:

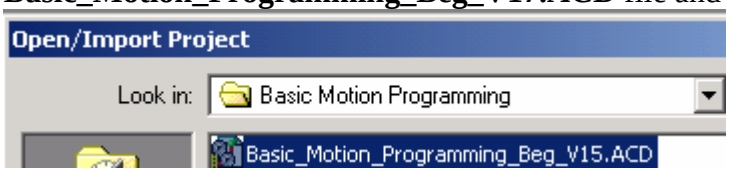
- Integrated Motion, Sequential Logic, and precise temperature control (PID) to eliminate the standalone temperature controllers. .
- An expandable system capable of handling additional axis for handling future pick and place units or controlling multiple machines.
- Future connectivity to a Rockwell Automation Visualization Product.
- 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 our Logix Integrated Motion solution with Kinetix 6000 drives offers all of the above. Your customer agrees and purchases the first system.

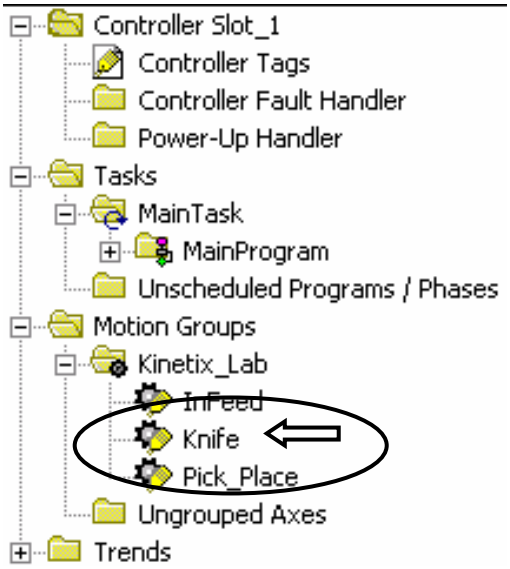
1. For the initial system, Premier Packaging has decided to replace the old controls with a 3 Axis Control Logix System using Kinetix 6000 Drives. Let's familiarize ourselves with the Logix Motion Instructions required to run the Shrink Wrap Machine. Open **RS Logix 5000** by clicking on the shortcut in the upper right corner of the desktop.



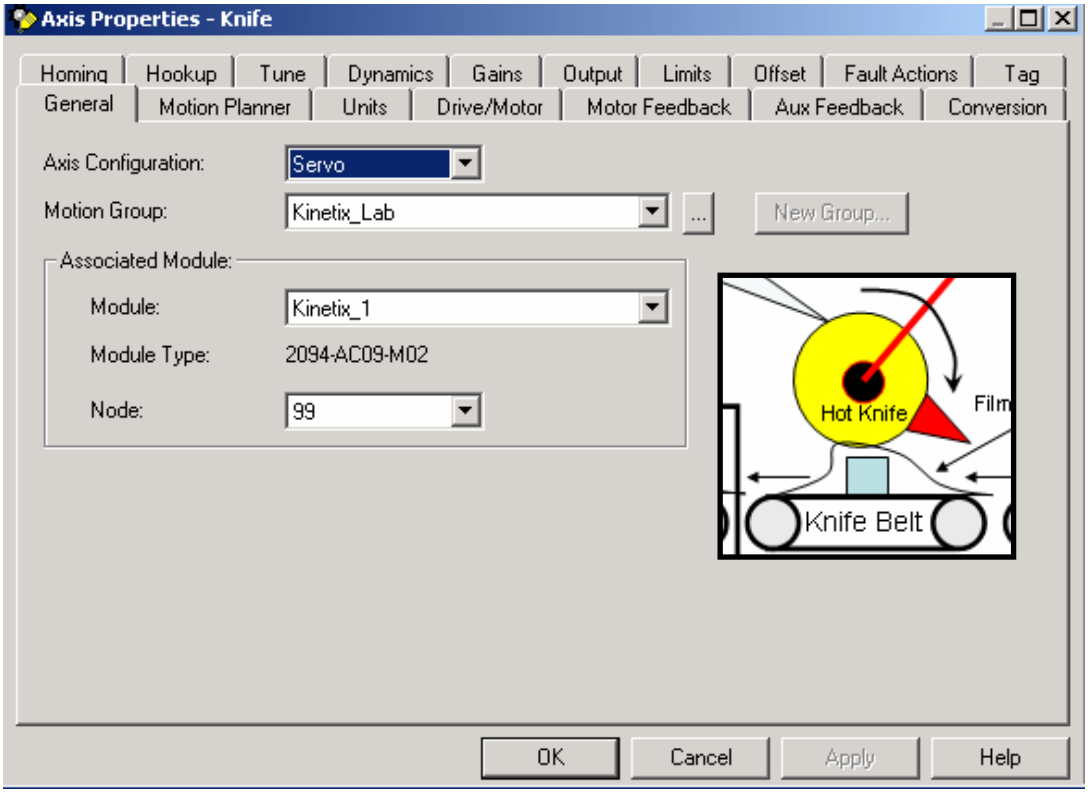
RS Logix 5000 will open. Select **File→Open→Local Disk (C:)→Motion HOT 2005→Basic Motion Programming.** Select the **Basic_Motion_Programming_Beg_V17.ACD** file and click on **Open**.



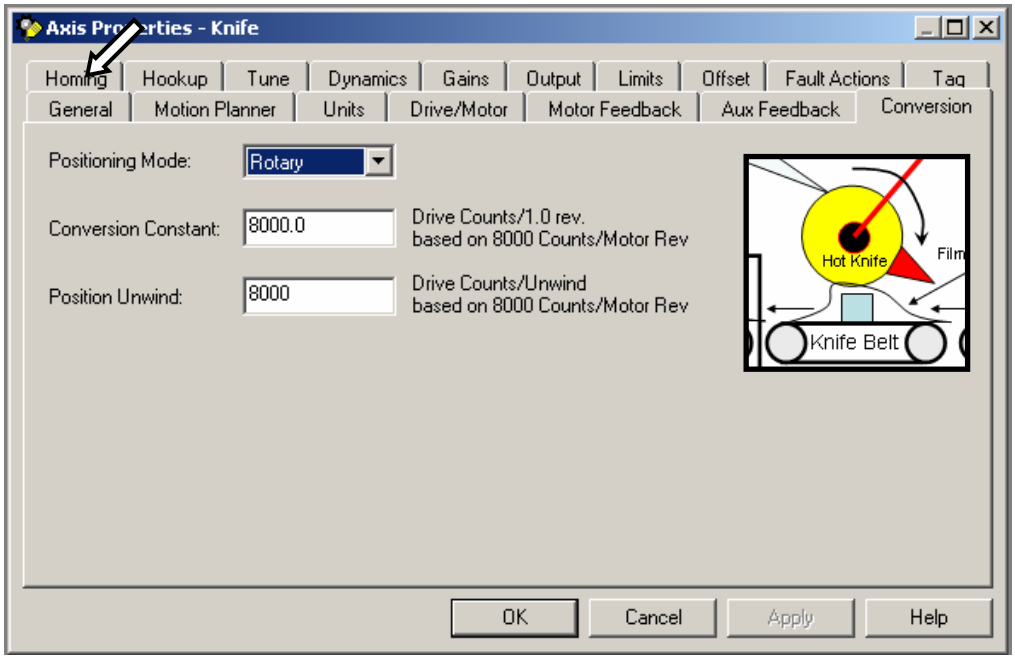
2. After the file opens, examine the **Controller Organizer Window**. Each Axis for the machine is preconfigured. Let's examine the properties for each axis individually. Select the **Knife Axis →Right Click→Properties**.



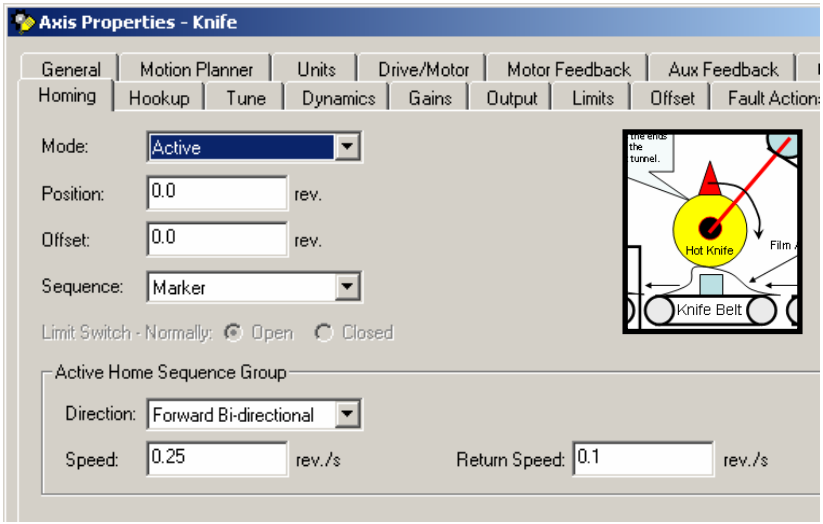
The Knife Axis is configured for **Node 99** which is the **IAM Module** and the **top MPL motor** on the drives demo. Select the **Conversion** Tab.



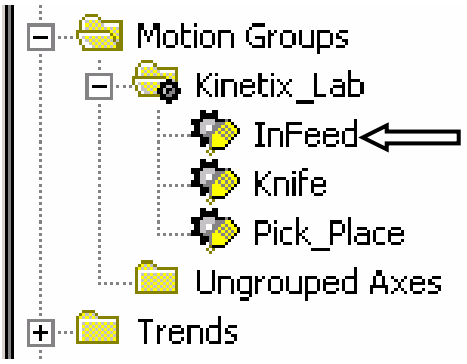
The **Knife** is configured as a **Rotary Axis** with **rev**. selected as the unit of measure. The axis will **rollover** every revolution. Other units of measure may be used such as radians, or degrees. To make the trend feature more useful later in the lab, rev. will be used. Select the **Homing** Tab.



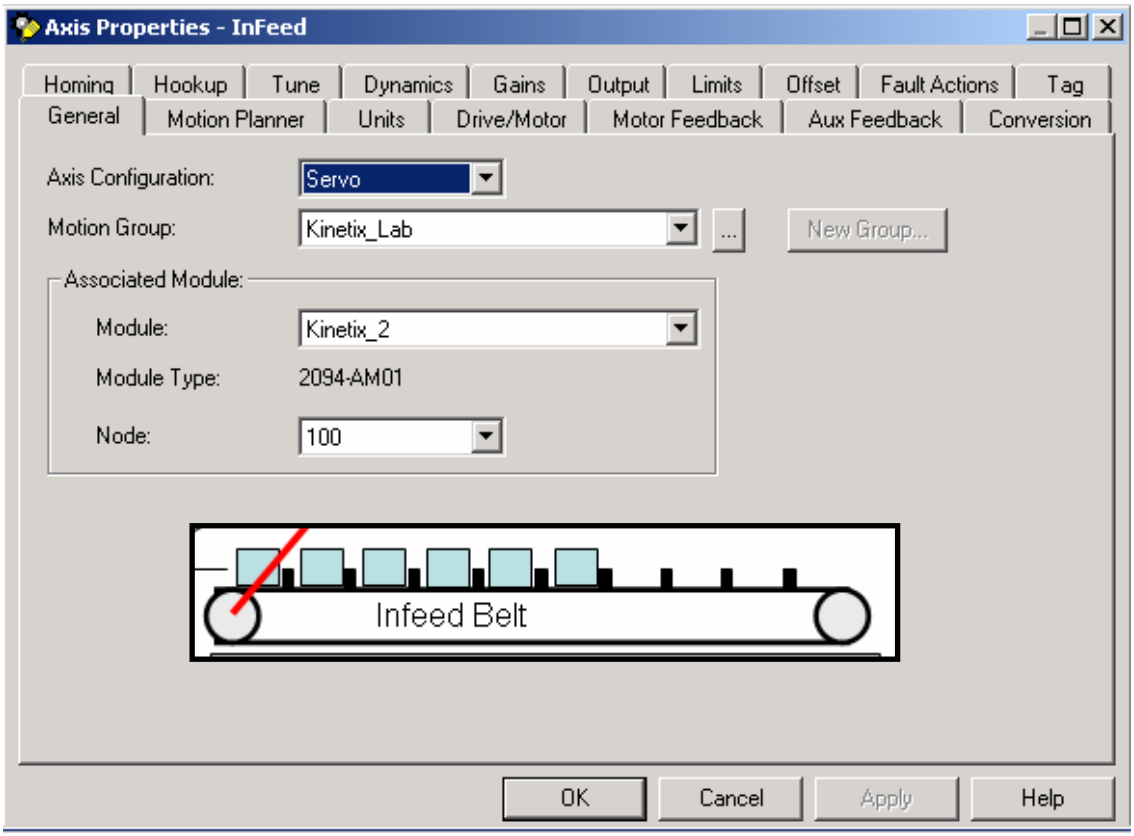
3. For the Knife, the Axis will home to the Marker. For a Rotary Axis that rolls over every revolution, homing to the marker is very accurate and a home switch isn't required. Select **OK** to close the Knife Properties Window.



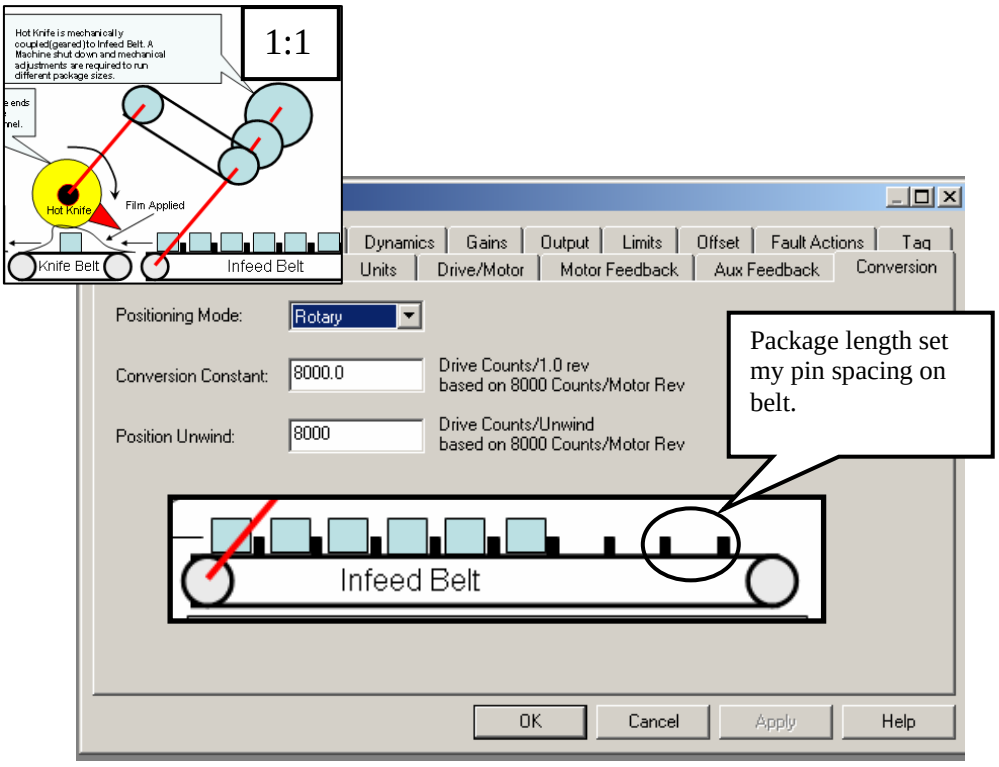
4. Select the **Infeed Axis →Right Click→Properties**.



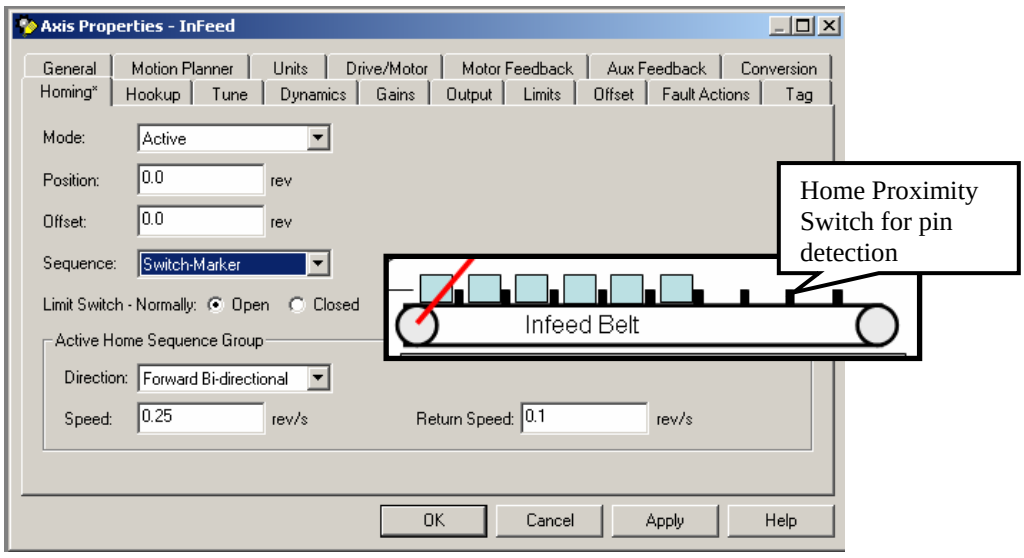
The Infeed Axis is configured for **Node 100** which is an **Axis Module** and the **bottom MPL motor** on the drives demo. Select the **Conversion Tab**.



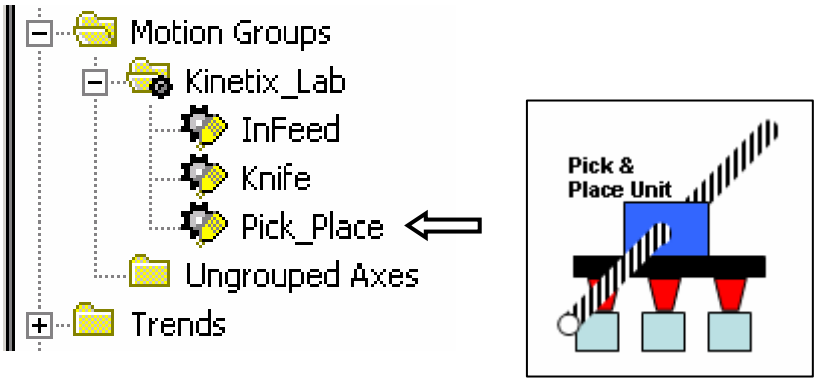
5. The Infeed Belt is also configured as a Rotary Axis. The pitch diameter of the belt roll is designed to move one package length per revolution of the motor for the largest package length as defined in the machine specification. Package spacing is determined by pin spacing on the belt. The old mechanical design required a pulley ratio of **(1:1)** between the Hot Knife and the Infeed Belt to move the largest packages through the machine. Select the **Homing Tab**.



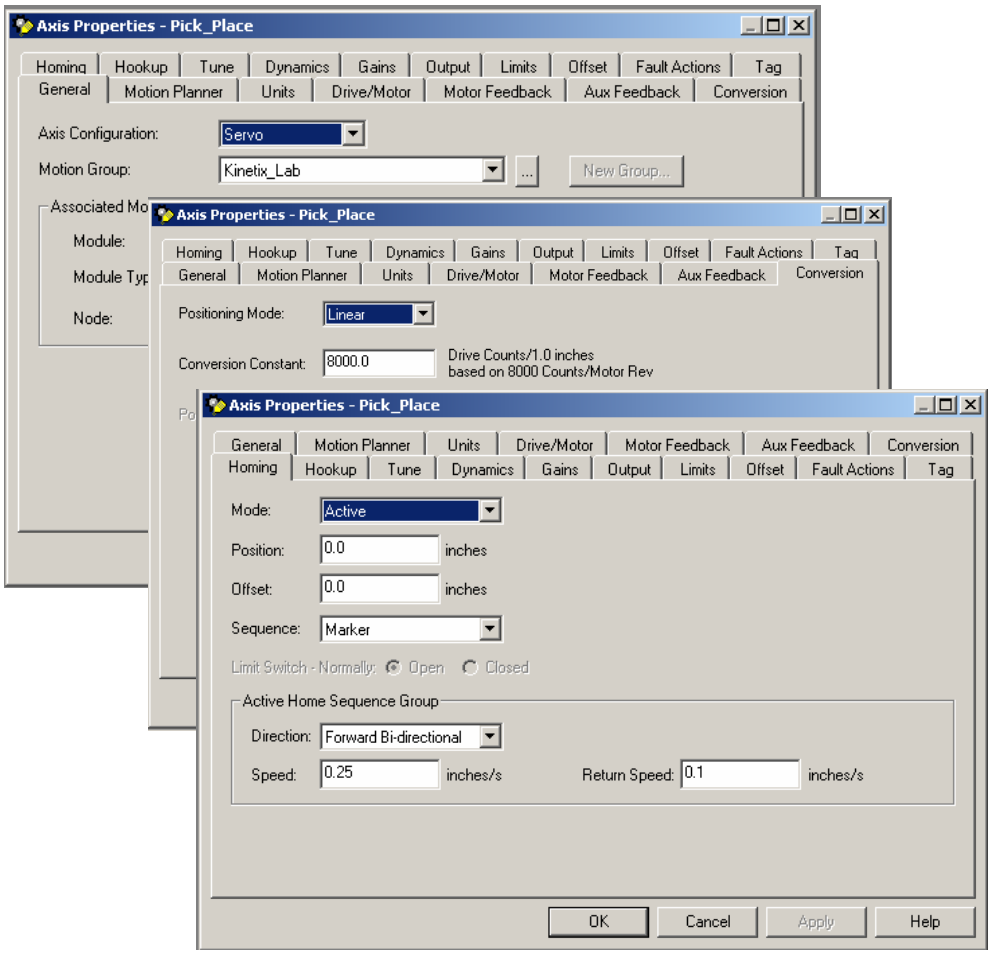
6. We will Home to a Switch-Marker to assure synchronization between the Knife and Infeed Belt. Click **OK and** close the Infeed property window.



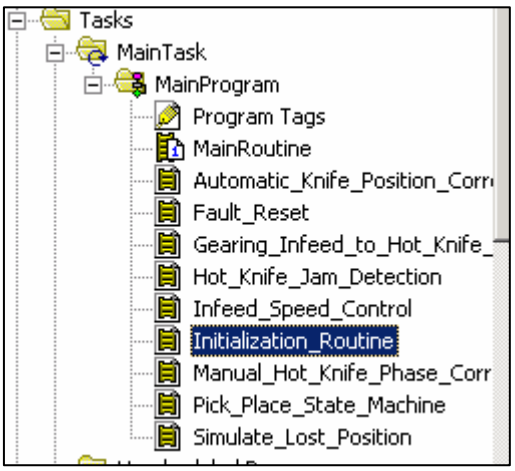
7. Select the **Pick_Place Axis →Right Click→Properties**.



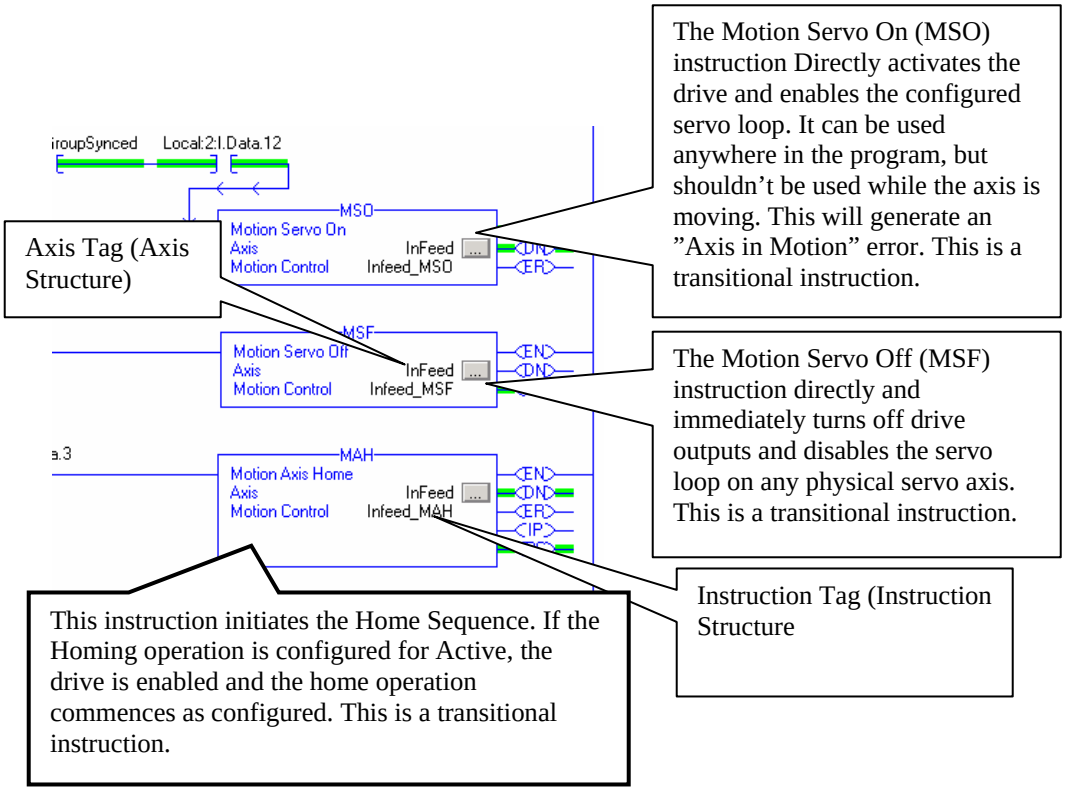
8. Review the **General→ Homing →Conversion** Tabs for the **Pick_Place** Axis. Click OK **and** close the **Pick_Place** property window.



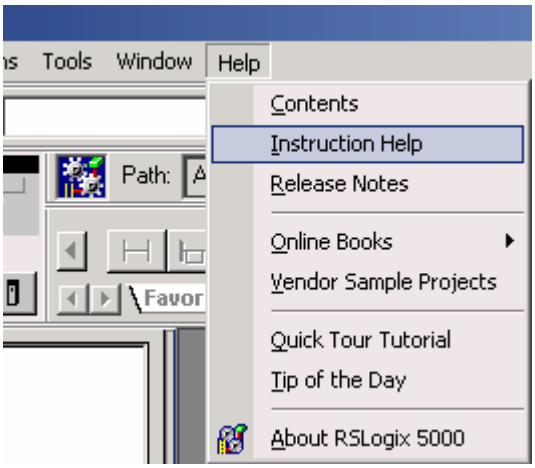
9. Let's cover the Logix Motion Instructions required to enable the drives and synchronize the machine Axis. **Double Click** on the **Initialization Routine** in the MainProgram Routine.



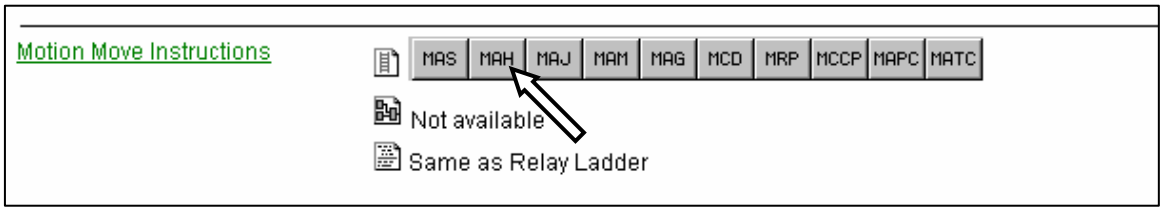
10. The three instructions shown below will Enable/Disable the **Infeed Drive** and **Home** the **Infeed** axis. Review the descriptions of each instruction below. Note, both **MSO** and **MAH** Instruction Enable the Drive. Enabling the Drive through an MSO, however, will allows the operator to move the axis prior to a home.



RSLogix has an exceptional **Instruction Help** menu. Select **Help→Instruction Help**.



11. Scroll down to the Motion Instructions for **Relay Ladder Instructions**. Let's briefly examine the Instruction Help for the **MAH** Instruction.

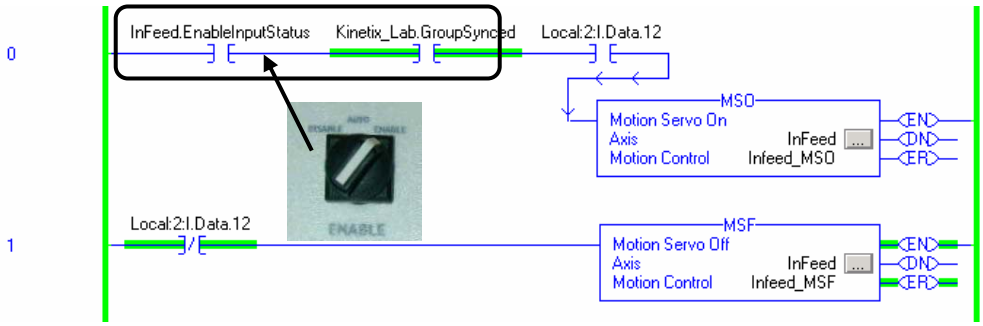


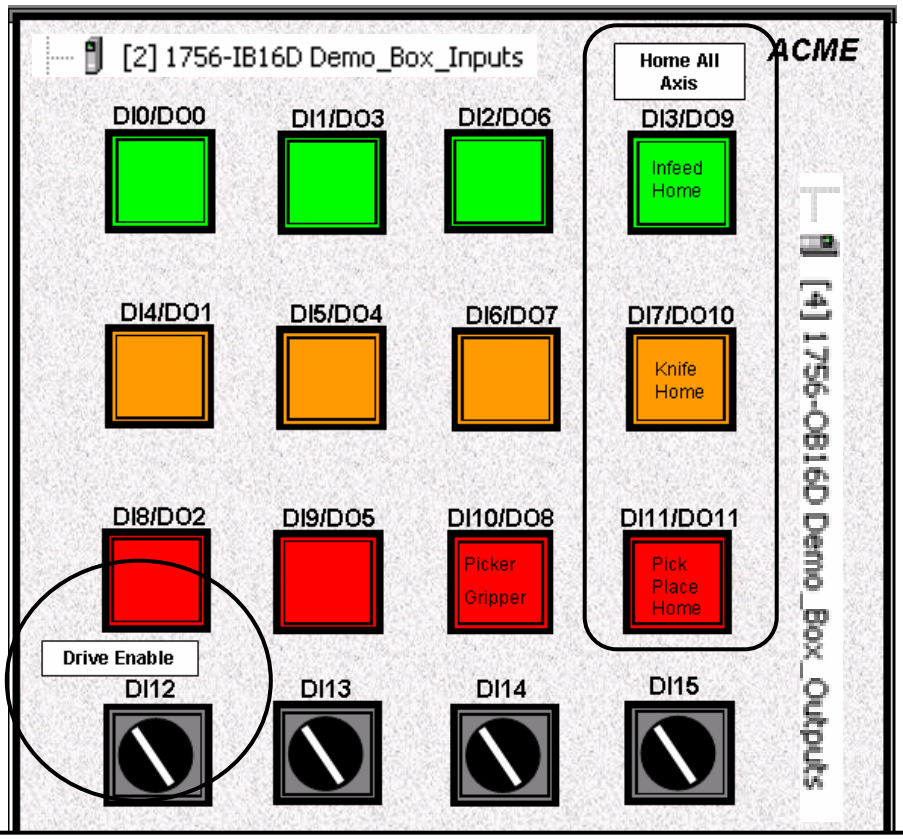
Error codes can be found in the Instruction Structure. The Error Descriptions in the Help menus are very useful when debugging the motion program.

Motion Axis Home (MAH)

Error	Error Code	Description
Execution Collision	3	The instruction tried to execute while another instance of this instruction was executing. This can occur when the servo module executes a messaging instruction without checking the .DN bit of the preceding instruction.
Shutdown State Error	7	Attempted to execute with the axis in the shutdown state.
Ilegal Axis Type	8	Attempted to execute, but the axis is not configured as a servo axis.
Axis Not Configured	11	The passed axis value references an unconfigured axis, meaning the axis has not been assigned to either a physical motion module channel or to a motion group.
Servo Message Failure	12	Messaging to the targeted motion module failed. See the Extended Error Codes section for more information.
Axis Type Unused	18	Attempted to execute on an axis that is not configured for use according to the current Axis Type Configuration attribute.
Axis Group Not Synchronized	19	Attempted to execute on an axis whose associated axis group is not currently synchronized.
Axis In Faulted State	20	Attempted to execute on an axis that is in the faulted state.
Group in Faulted State	21	Attempted to execute on an axis in a group that is in the faulted state.
Axis in Motion	22	Attempted to execute on an axis while the axis was in motion.

12. Download the project to the controller and place the processor into **Rem Run**. The InFeed Axis is enabled by turning the **DI12** to the right and Disabled by turning **DI12** to the left. ***Most machines incorporate an E-Stop string***, so the **Drive Enable status** bit in the axis structure along with the **Motion Group Synced** bit in the **Motion Group Structure** are used to condition the rung. Test the operation of the rung. Use the **ENABLE** selector switch for **Axis 2** on the Kinetix demo to simulate an E-Stop string closure. The ENABLE switch is wired to disable the drive.



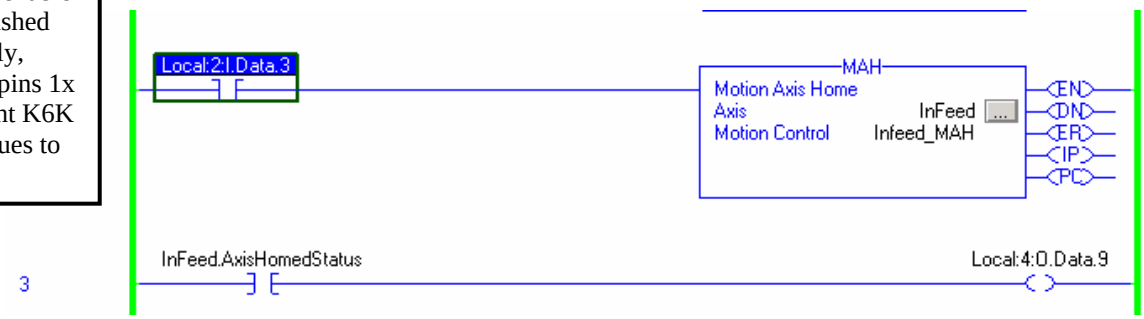


There are 8 switches on the K6K demo box as well. All switches should be turned to the left EXCEPT the two ENABLE switches. The ENABLE switches should be turned to the right (on).

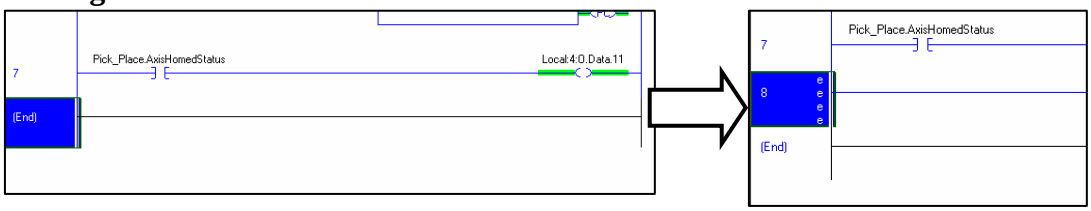
Don't forget to wait for the drive to phase up to 4 before switching DI12. See the Status or Fault/Status displays on the drives for this number. When the drives are enabled with DI12 you will notice that there is torque applied to Motor_X and the right wheel in the K6K demo box. When the drives are disabled with DI12 you will notice that you can easily turn Motor_X and the right wheel of the K6K demo box.

13. Examine the Homing Logic for the Infeed Axis. Press and release the **Home Button (DI3).** The Infeed Axis will move in the positive direction indefinitely until the **Home Switch** on Axis Two of the Kinetix Demo is toggled and released. At that point, the Axis will reverse direction and return to the Marker and the **InFeed.AxisHomed Status** will bit will be set. In addition to the Infeed axis, logic is included to Home the **Pick_Place** Axis. The **Pick_Place** Axis is configured to Home to the Marker, so a Home Switch(Button) isn't required. Let's get some practice programming the Knife Axis **MSO**, **MSF** and **MAH** Logic.

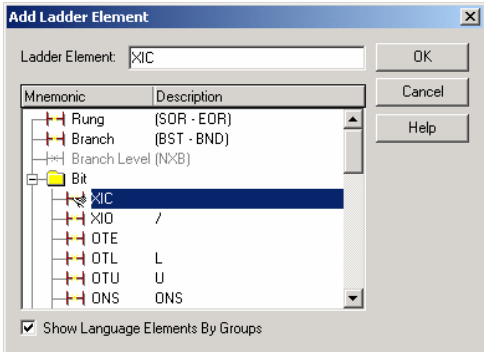
With DI12 enable and DI3 pushed momentarily, Motor_X spins 1x and the right K6K axis continues to spin.



14. Go offline and scroll to the end of the Initialization Routine. **Right Click→Add Rung**.

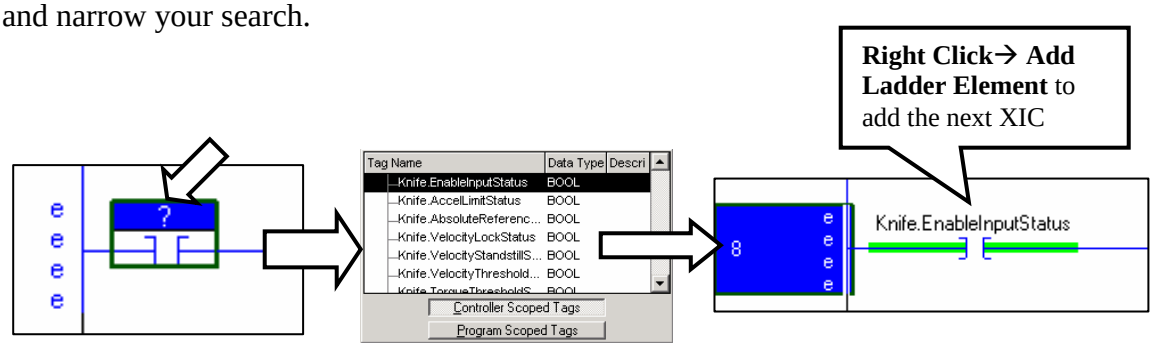


Right Click→Add Ladder Element. Expand the Bit Folder, select **XIC** and Click **OK**.

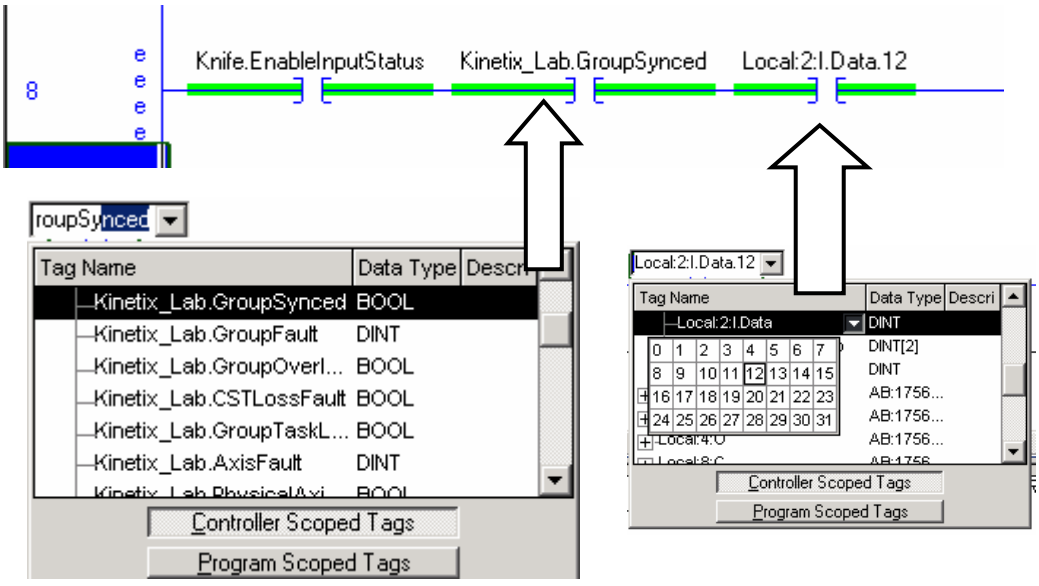


You can also select the **Insert Key** to add a rung, and then **Insert** again to display the Add Ladder Element window.

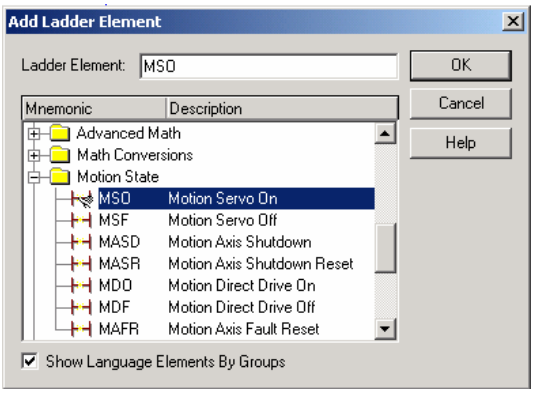
15. Double Click on the question mark and select the pull down arrow to display tags. **Axis Structure Tags** are found under **Controller Scope**. Double Click on **Knife.EnableInputStatus** to accept the **XIC**. Scrolling for a status bit can be time consuming. If you know the name of your status bit, start typing it (i.e. **Knife.E**…) after double clicking on the instruction ?. RS-Logix will advance automatically and narrow your search.

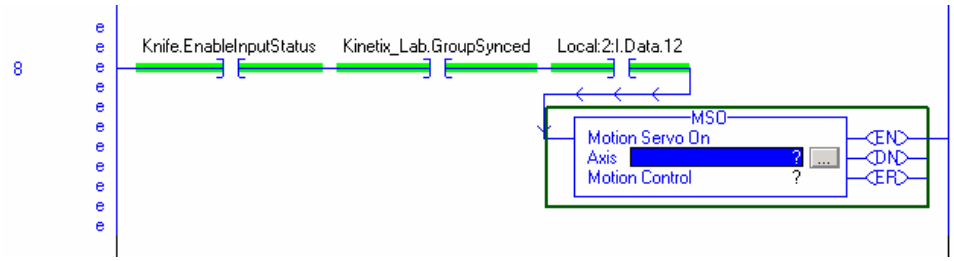


Lets add the XIC elements for the Kinetix_Lab.GroupSynced and the Drive Enable Selector Switch (DI12) XIC elements in series with the **Knife.EnableInputStatus XIC**.

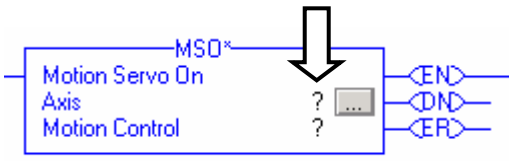


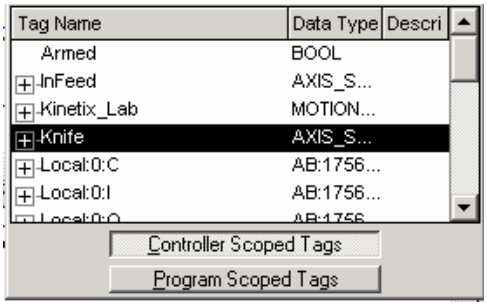
Ladder Elements can be added using many methods. Many methods are covered in Basic ControlLogix classes. Let's complete the rung by adding the MSO Instruction. Right Click on the **Local:2:I.Data.12 XIC** and add the **MSO**.



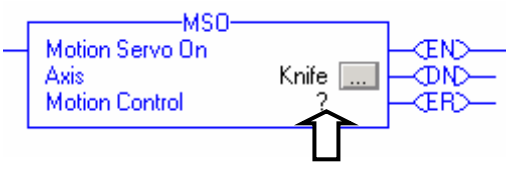


Double Click on the Axis field and select the **Knife** axis. Double Click on the **Knife** axis to accept.

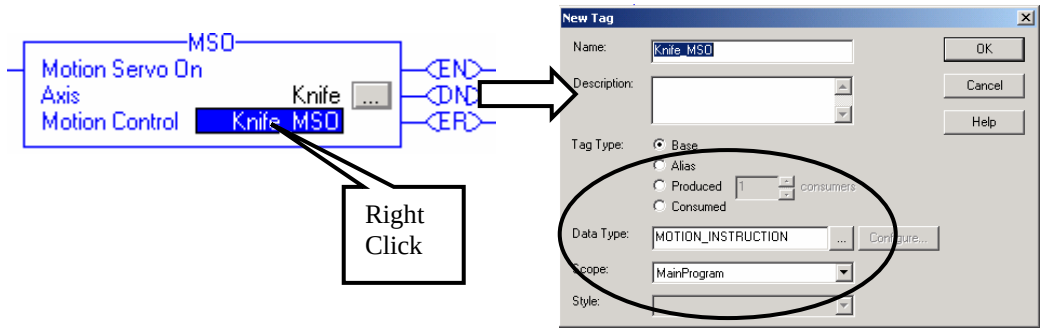




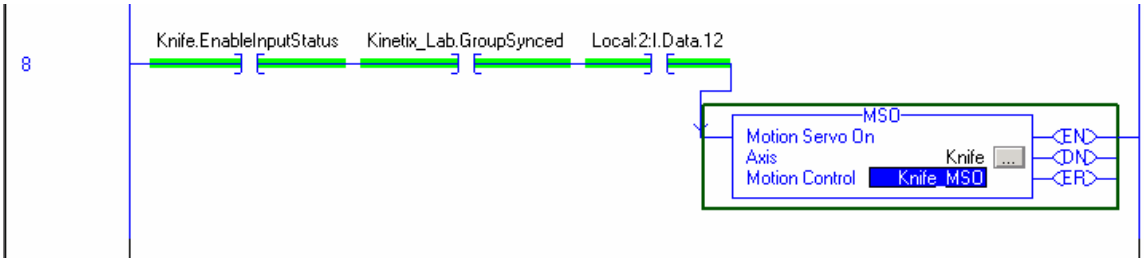
Select the Motion Control field and type the name **Knife_MSO**. Press the Enter key on the computer to accept.



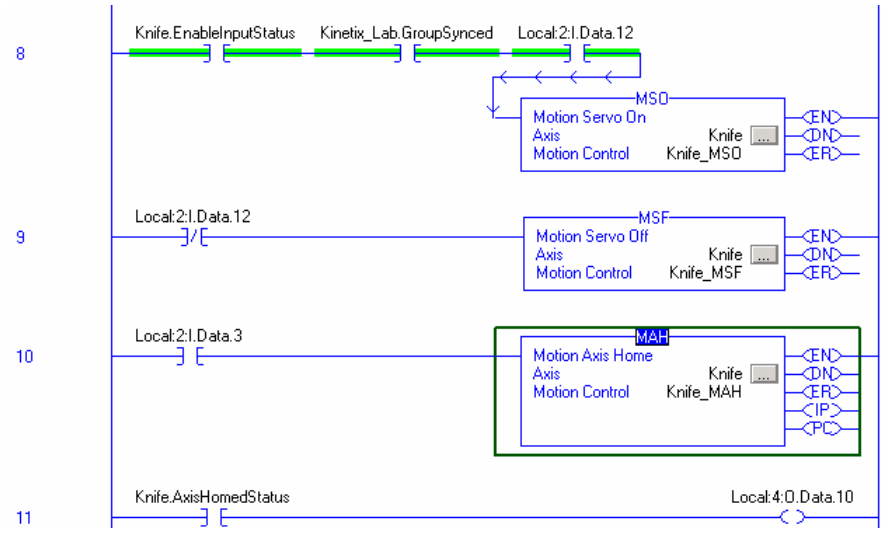
16. The Motion Control field is used in every Logix Motion Instruction. This field contains the unique tag or **"Instruction Structure"**for each Motion Command**.** The status bits and error data contained within a structure are used for sequencing Motion Commands and for diagnostics. Right Click on **Knife_MSO** and select **New "Knife_MSO"** Select a Data Type of **Motion Instruction** and a **Main Program** Scope.



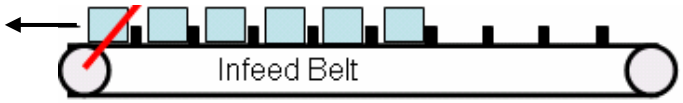
Select OK to create the new Instruction Structure Tag "Knife_MSO" for the MSO. This completes the rung.



17. Enter the remaining rungs displayed below, download and test operation. Remember to right click on the Motion Control Field to create a new Instruction Structure for each Motion Instruction. When you're finished, close the Initialization Routine.

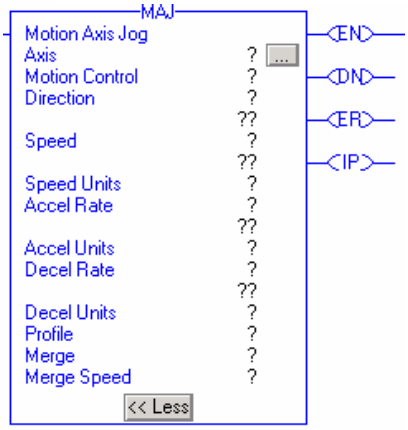


18. The next step is to program the Infeed belt to move continuously at a given speed and direction to move packages into the Knife area of the machine. The best Logix Motion Instruction for this task is the **Motion Axis Jog(MAJ)**.



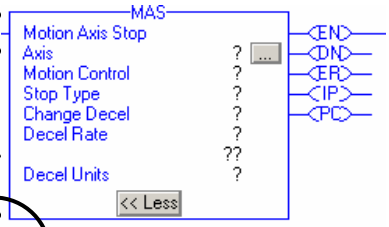
The **Motion Axis Jog (MAJ)** instruction jogs (moves continuously) a physical axis in the specified direction using a specified speed, acceleration and deceleration. This is a transitional instruction. Toggle the rung condition from cleared to set each time the instruction needs to be executed. A description of each Instruction Operand is provided in the table below.

Operand:	Type:	Format:	Description:
Axis	AXIS_VIRTUAL AXIS_GENERIC AXIS_SERVO AXIS_SERVO_DRIVE	tag	Name of the axis to perform operation on.
Motion control	MOTION_INSTRUCTION	tag	Structure used to access instruction status parameters.
Direction	UDINT	immediate or tag	Direction of jog. Select either: 0 = forward jog 1 = reverse jog
Speed	REAL	immediate or tag	Speed to move the axis in % or Speed Units.
Speed units	UDINT	immediate	Engineering units in which the Speed value is displayed. Select either: 0 = units per sec 1 = % of maximum speed
Accel rate	REAL	immediate or tag	Accel rate of the axis in % or Acceleration Units
Accel units	UDINT	immediate	Engineering units in which the Acceleration value is displayed. Select either: 0 = units per sec^2 1 = % of maximum acceleration
Decel rate	REAL	immediate or tag	Deceleration rate of the axis in % or Deceleration Units.
Decel units	UDINT	immediate	Engineering units in which the Deceleration value is displayed. Select either: 0 = units per sec^2 1 = % of maximum deceleration
Profile	UDINT	immediate	select the velocity profile to run the jog: 0 = trapezoidal 1 = S-curve
Merge	UDINT	immediate	When enabled, Merge instructs the motion control to turn all current axis motion, regardless of the motion instructions currently in process, into a pure jog governed by this instruction. Select either: 0 = disabled 1 = enabled

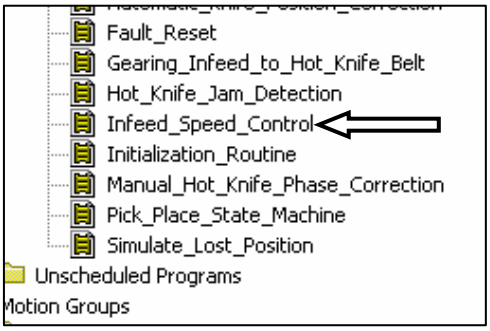


Transitional Instructions are activated and run to completion. The **MAJ** will run indefinitely, unless we tell it to stop. The Logix Motion Instruction used to stop a **MAJ** is a **Motion Axis Stop(MAS).** The **Motion Axis Stop(MAS)** is used to initiate a controlled stop of any Motion process without disabling the servo loop. Examine the **Stop Type Operand** descriptions to gain a feel for the scope of this instruction.

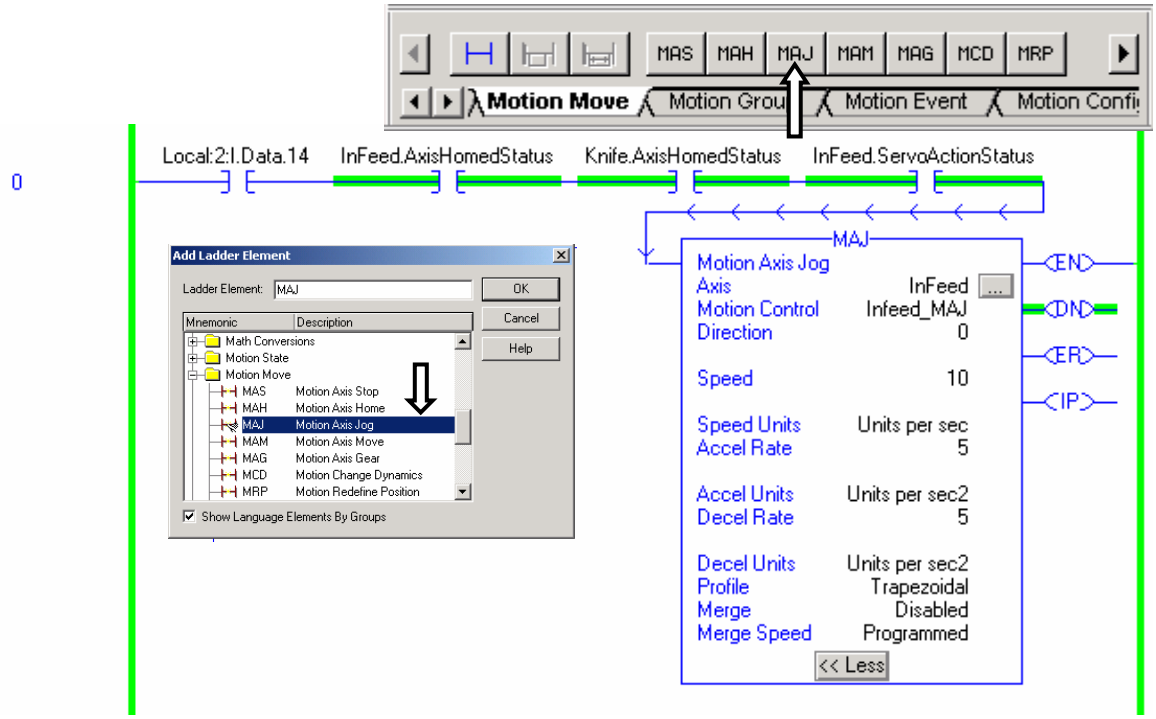
Operand:	Type:	Format:	Description:
Axis	AXIS_VIRTUAL AXIS_GENERIC AXIS_SERVO AXIS_SERVO_DRIVE	tag	Name of the axis to perform operation on.
Motion control	MOTION_INSTRUCTION	tag	Structure used to access instruction status parameters.
Stop type	UINT32	immediate	Determines what motion process on the specified axis to stop. Options are: 0 = stop all motion 1 = stop jogging 2 = stop moving 3 = stop gearing 4 = stop homing 5 = stop tuning 6 = stop test 7 = stop position camming 8 = stop time camming 9 = stop a Master Offset Move
Change Decel	Boolean	immediate	Set to enable use of the instruction's Decel value rather then the current configured Max Deceleration rate. Select either: 0 = no 1 = yes
Decel rate	REAL	immediate or tag	Deceleration rate of the axis in % or Deceleration Units
Decel units	Boolean	immediate	Engineering units in which the Decel value is displayed. Select either: 0 = units per sec^2 1 = % of maximum



19. Double Click on **Infeed_Speed_Control** Routine.



20. Program the rung below to Jog (Move Continuously) the Infeed belt at 10 inches/sec. You can locate the MAJ Instruction in the **Motion Move Element Group** or by right clicking on a rung element and selecting **Add Ladder Element**. **Choose Main Program Scope for all newly created tags.**

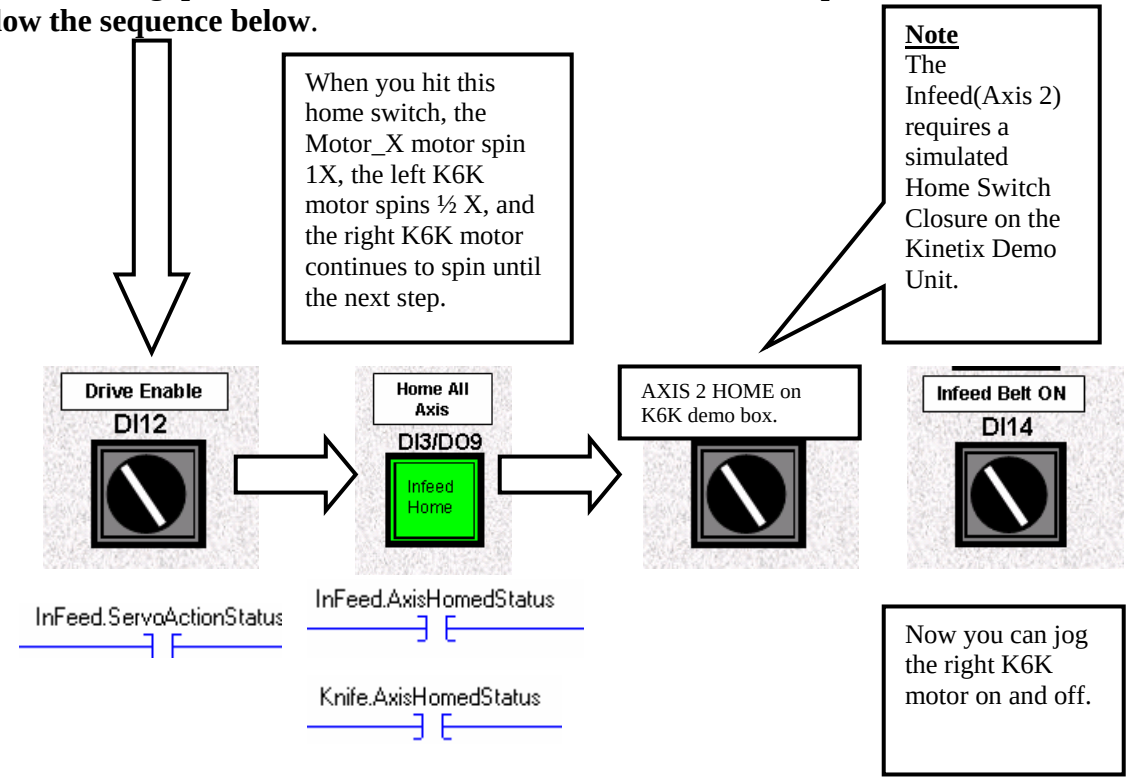


Program the Rung Below.

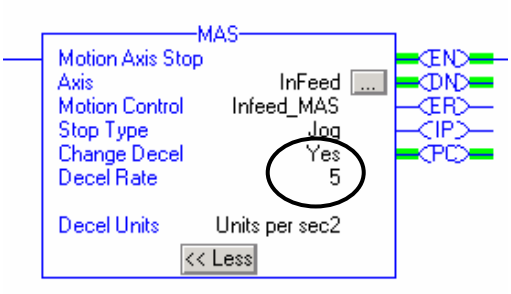
Download to the Controller and put the processor in **Rem Run**.

21. View your Logic. Based on your entered logic, the Drive must be **Enabled** and all axis must be homed (synchronized). The Axis Structure Status bits are used in the **MAJ** rung to assure that all conditions are met prior to motion. **Enable the drive** by turning on **DI12**, **Home** all Axis by pressing **DI3** on the Logix Demo and **AXIS 2 HOME** on K6K demo. After all axes are Homed, turn the **Infeed Belt (DI14) On and Off** and observe the Kinetix Drive.

Before enabling, put all white markers to the front and 12 noon positon.
Follow the sequence below.

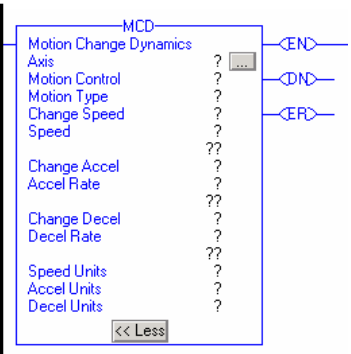


When the **Infeed Belt** is turned on, it accelerates at 5 in/sec^2. When it's turned off, it decelerates at the configured **Maximum Deceleration Rate (reference Dynamics Tab in Axis Properties.** On a real machine, an abrupt deceleration can cause damage. Let's fix the problem. Go **Offline** and make the changes below to Rung 1 in the **Infeed Speed Control** routine. Download and test. The **Infeed Belt** will decelerate at 5 in/sec^2.



22. The Infeed belt Jogs nicely, but now we need to vary the speed. Different packages require different package feedrates. The Instruction required to do the job is the Motion Change Dynamics(MCD). The MCD instruction changes the speed, acceleration and deceleration of trapezoidal profiles moves on the fly. The MCD is a transitional instruction.

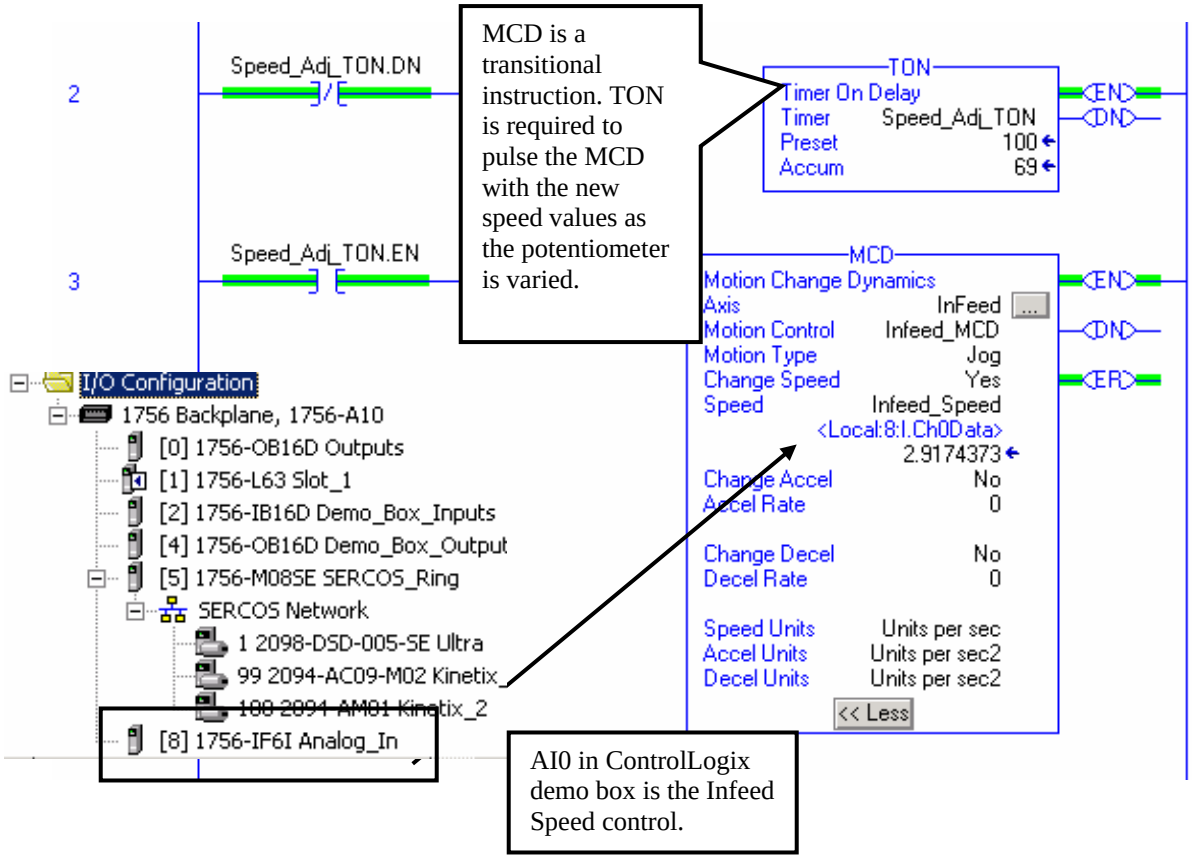
Operand:	Type:	Format:	Description:
Axis	AXIS_VIRTUAL AXIS_GENERIC AXIS_SERVO AXIS_SERVO_DRIVE	tag	Name of the axis to perform operation on.
Motion control	MOTION_INSTRUCTION	tag	Structure used to access instruction status parameters.
Motion type	UDINT	immediate	Motion profile (jog or move) to change. Select either: 0 = jog 1 = move



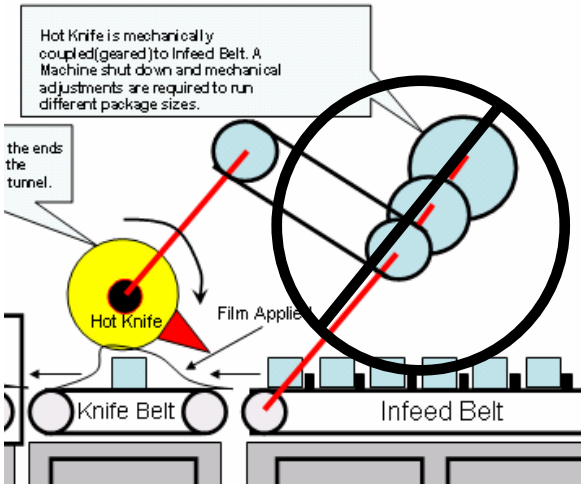
Operand:	Type:	Format:	Description:
Change speed	BOOLEAN	immediate	Set to enable a change of speed. Select either: 0 = no 1 = yes
Speed	REAL	immediate or tag	The new Speed to move the axis in % or Speed Units.
Change accel	BOOLEAN	immediate	Set to enable an acceleration change. Select either: 0 = no 1 = yes
Accel rate	REAL	immediate or tag	The acceleration rate of the axis in % or Acceleration units.
Change decel	BOOLEAN	immediate	Set to enable a deceleration change. Select either: 0 = no 1 = yes
Decel rate	REAL	immediate or tag	The deceleration rate of the axis in % or Deceleration units.
Speed units	BOOLEAN	immediate	Units used to display the Speed value. Select either: 0 = units per sec 1 = % of maximum speed
Accel units	BOOLEAN	immediate	Units used to display the Acceleration value. Select either: 0 = units per sec^2 1 = % of maximum acceleration
Decel units	BOOLEAN	immediate	Units used to display the Deceleration value. Select either: 0 = units per sec^2 1 = % of maximum deceleration

23. Add the rungs below to the **Infeed_Speed_Control** Routine. The Infeed_**Speed Tag**(Program Scope) has been created and is an alias for **AI0(potentiometer on Logix Demo)**. The MCD in our example is used to change the speed of the infeed belt. **Save** and **Download** to the processor and test your logic. Place the processor in the **Rem Run** mode. *Prior to testing your logic,turn on the Drive Enable(DI12) and Home(DI3) all the axis. You'll need to follow this sequence after every program download*. Turn on the **Infeed Belt** and rotate the **AI0** potentiometer. The speed will change. This is a simple exercise, yet very powerful. Our speed is now a variable capable of being accessed and changed from a visualization product, from a recipe or from a Level II production scheduling system via one of Rockwell's network solutions.

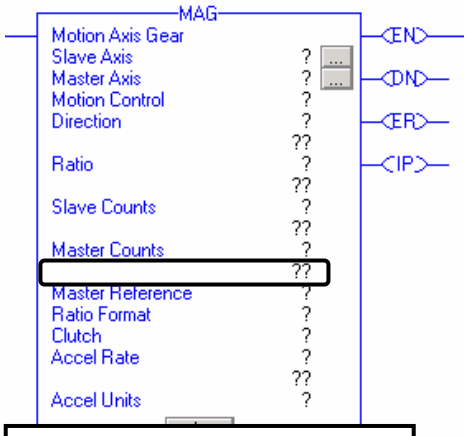
Remember the sequence is: wait for SERCOS drive to get to phase 4, turn on DI12 to enable, push DI3 to home Pick and Place (Ultra) and Knife (left K6K), turn AXIS 2 HOME to home Infeed belt (right K6K), then turn on DI14 to jog the Infeed belt (right K6K). To vary the speed of the Infeed belt (right K6K) vary the position of AI0 of the ControlLogix demo box.



24. Premier packaging has decided to immediately take advantage of the **Electronic Gearing** feature available in the Logix platform This will eliminate the pulley system and the associated cost of tearing down the machine to make mechanical pulley adjustments when smaller packages are ran through the machine.

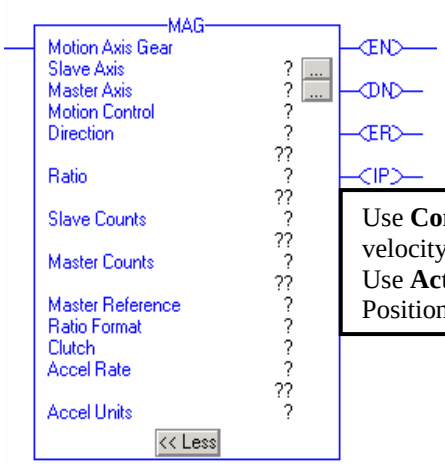


The Motion Axis Gear (MAG) instruction enables electronic gearing between two axes at a specified ratio. On the Premier Machine, The **Infeed Belt** axis is the Master and the **Hot Knife** axis is the Slave. Both are programmed in **Revs/sec.** Initially, the largest package will be run through the machine and a 1:1 ratio will be used. The Knife will match the speed of the Infeed Belt(revs./sec.) exactly.



Used when ratios are in whole units. For example for 1:1, enter 1. For 2:1, enter a 2.
When fractional ratios(1.45:1) are required, enter the ratio of slave counts to master counts.
Use the **Ratio Format** Operand to select the format used.

Operand:	Type:	Format:	Description:
Slave axis	AXIS_VIRTUAL AXIS_GENERIC AXIS_SERVO AXIS_SERVO_DRIVE	tag	Name of the axis to perform operation on.
Master axis	AXIS_FEEDBACK AXIS_CONSUMED AXIS_VIRTUAL AXIS_GENERIC AXIS_SERVO AXIS_SERVO_DRIVE	tag	The axis that the slave axis follows.
Motion control	MOTION_INSTRUCTION	tag	Structure used to access instruction status parameters.
Direction	UINT32	immediate or tag	The relative direction that the Slave axis tracks the Master Axis. Select one of following: 0 = slave axis moves in the same direction as the master axis 1 = slave axis moves in the opposite direction of its current direction 2 = slave axis reverses from current or previous 3 = slave axis to continue its current or previous direction
Ratio	REAL	immediate or tag	Signed Real value establishing the gear ratio in Slave User Units per Master User Unit.



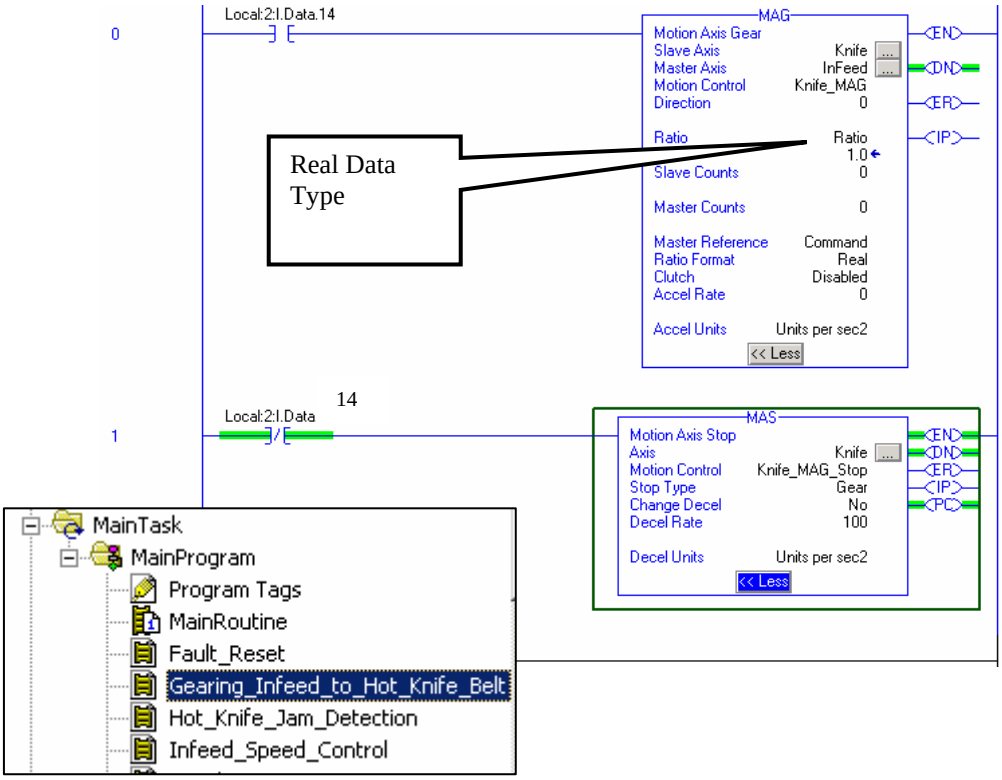
Operand:	Type:	Format:	Description:
Slave counts	UINT32	immediate or tag	Integer value representing slave counts used in specifying a Fractional gear ratio.
Master counts	UINT32	immediate or tag	Integer value representing master counts used in specifying a Fractional gear ratio.
Master reference	BOOLEAN	immediate	Sets the master position reference to either Command position or Actual position. 0 = Actual – slave axis motion is generated from the current position of the master axis as measured by its encoder or other feedback device. 1 = Command – slave axis motion is generated from the desired or commanded position of the master axis.
Ratio format	BOOLEAN	immediate	The desired ratio specification format. Select either: 0 = real gear ratio 1 = integer fraction of slave encoder counts to master encoder counts
Clutch	BOOLEAN	immediate	When Clutch is enabled, motion control ramps the slave axis up to gearing speed at the instruction's defined Acceleration value. If not enabled, the Slave axis immediately locks onto the Master axis. If the Master Axis is currently moving this condition results in an abrupt "uncontrolled" acceleration event of the Slave Axis which can cause the axis to fault. Select either: 0 = enabled 1 = disabled
Accel rate	BOOLEAN	immediate or tag	Acceleration rate of the Slave Axis in % or Acceleration Units. It is applied when the Clutch feature is enabled.
Accel units	DINT	immediate	The units used to display the Acceleration value. Select either: 0 = units per sec^2 1 = % of maximum acceleration

Use **Command** for smooth velocity control.
Use **Actual** for tight Position Control.

On the Premier Machine, Gearing on the Infeed Belt and the Knife will be enabled simultaneously. Therefore the knife will accelerate smoothly at 5 revs/sec as it tracks the Infeed belt. If the infeed was moving at steady state when gearing was enabled, the clutch feature would be used to prevent abrupt motion.

If you've ever driven a stick shift, compare Accel Rate/Decel Rate to how fast you release the clutch.

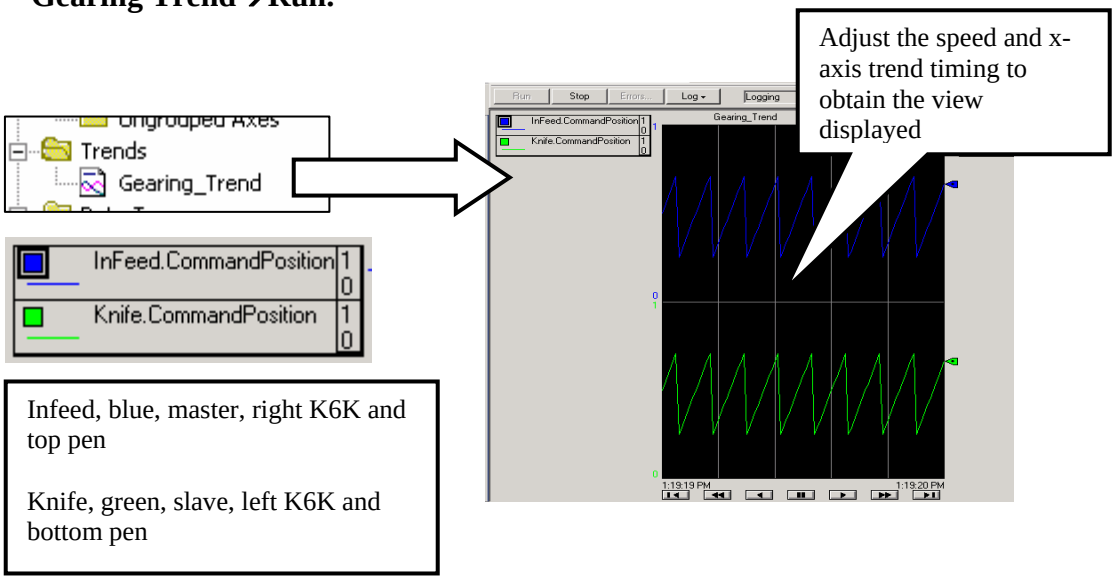
26. Go offline and enter the rungs below into the **Gearing_Infeed_to_Hot_Knife_Belt** routine. **Save→Download→Rem Run and** test the operation.



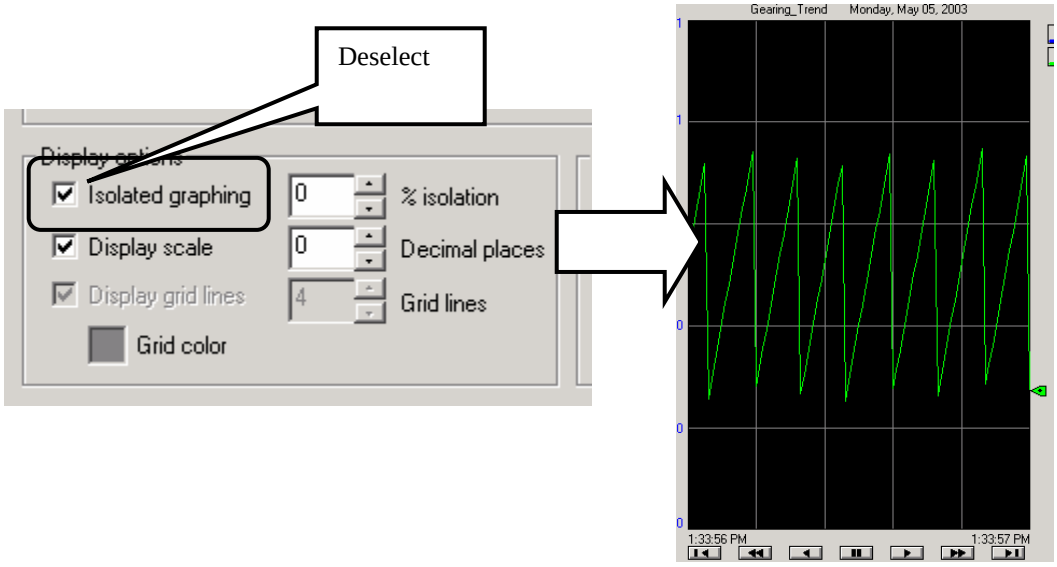
27. *Prior to testing your logic, turn on the **Drive Enable(DI12)** and **Home(DI3)** all the axes. You'll need to follow this sequence after every program download*. **DI14** has two functions. The selector switch enables the **Infeed Jog** operation and turns on **Gearing**. Turn on **DI14** and observe operation.

The sequence is:
Before the download turn off DI12 and DI14. Download. Go to run mode. Wait for SERCOS drive to get to phase 4, turn on DI12 to enable, push DI3 to home Pick and Place (Ultra) and Knife (left K6K), turn AXIS 2 HOME to home Infeed belt (right K6K), then turn on DI14 to jog the Infeed belt (right K6K). To vary the speed of the Infeed belt (right K6K) vary the position of AI0 of the ControlLogix demo box. Because gearing is now programmed and running the Knife (slave and left K6K) turns at the same rate as the Infeed belt (master and right K6K). The rate is 1:1 because that is what we loaded into Ratio for the MAG instruction.

28. The **Infeed** and **Knife** should track each other in a 1:1 relationship. Adjust the **AI0** potentiometer and observe the speed of both axis. Double Click on the **Gearing Trend→Run.**

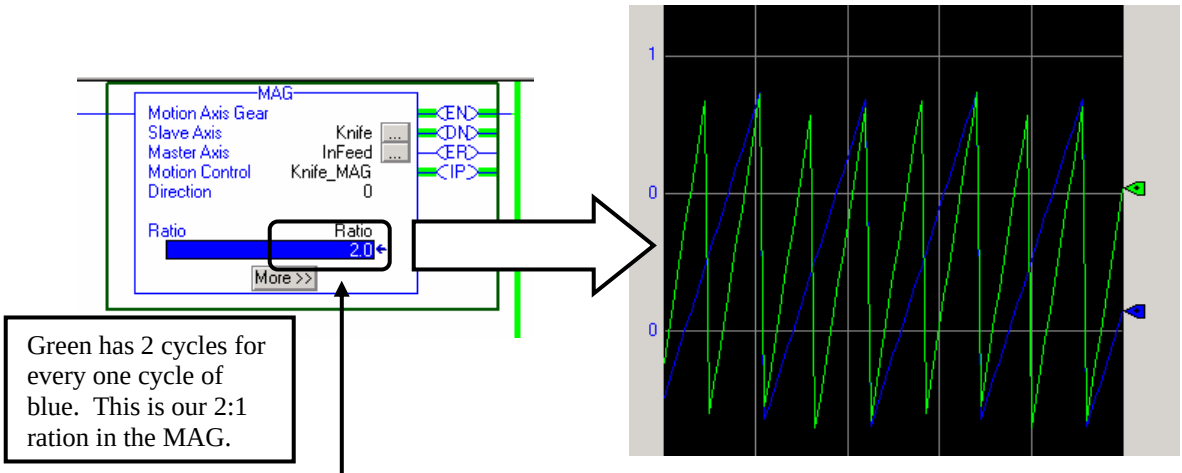


Commanded Position for the Infeed and Knife are monitored in the trend above. We can display how tightly the axis are synchronized by disabling the isolated trending feature. To accomplish this, place the mouse pointer over the trend area. **Right Click→Chart Properties→Y-Axis→ Deselect Isolated Graphing→OK**.



It appears like the Infeed Position(Blue Pen) has been eliminated. In reality, they are tracking very closely and the Infeed is hidden behind the Knife commanded position. Close the **Gearing Trend**.

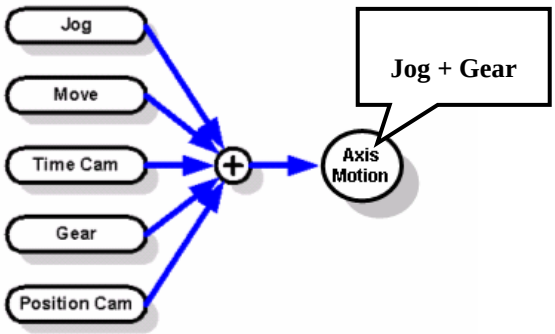
29. Double Click on the Ratio Operand in the MAG Instruction and change the Ratio to 2. Turn **DI14** off. **Home** the Axis. Turn **DI14** back on. The new ratio will take effect. Select the **Gearing Trend→Run**. The **Knife** is still synchronized to the **Infeed** belt, but makes two revs for every revolution of the **Infeed** belt motor.



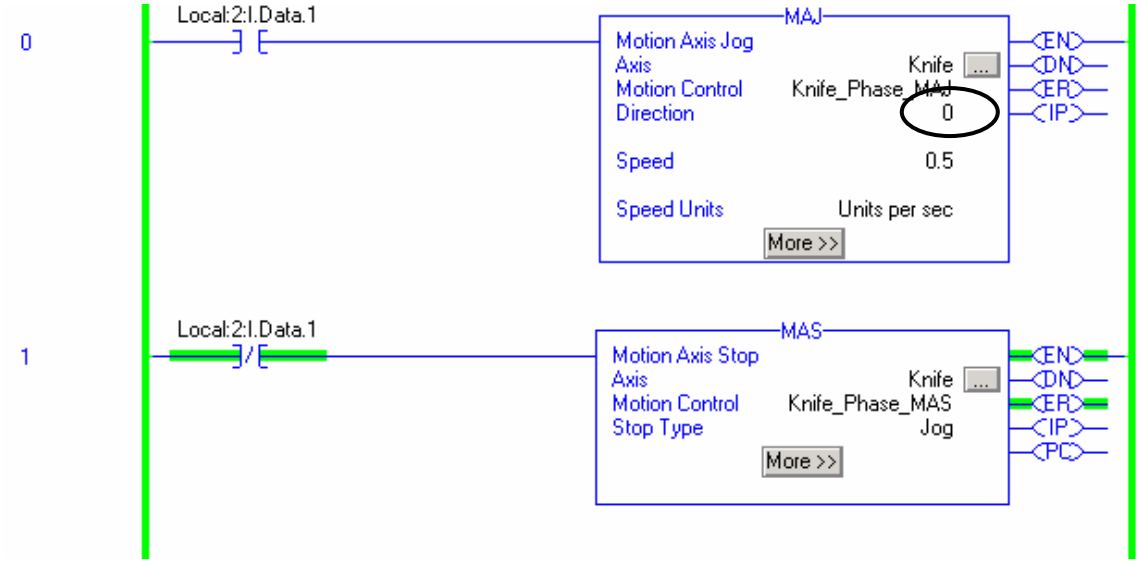
Close the trend. Return the Ratio to 1.

30. Machines are rebuilt every two years because machine parts wear causing positioning inaccuracies. Prior to retrofitting the machine and electronically gearing the Knife to the Infeed Belt, and operator could turn a crank and manually advance or retard the position of the knife(phase adjustment) while the machine was running. Let's add a routine to replace the crank.

The simple diagram below provides insight into the inner workings of Logix Motion. Motion can be generated from several sources or instruction categories. One can simultaneously execute a Motion Axis Jog(MAJ) and a Motion Axis Gear(MAG). The actual motion will be the summation of both unless Merge is enabled which will be demonstrated later in this lab. To replace the mechanical crank, we will simply add logic to Jog the Knife in both directions while gearing is enabled.

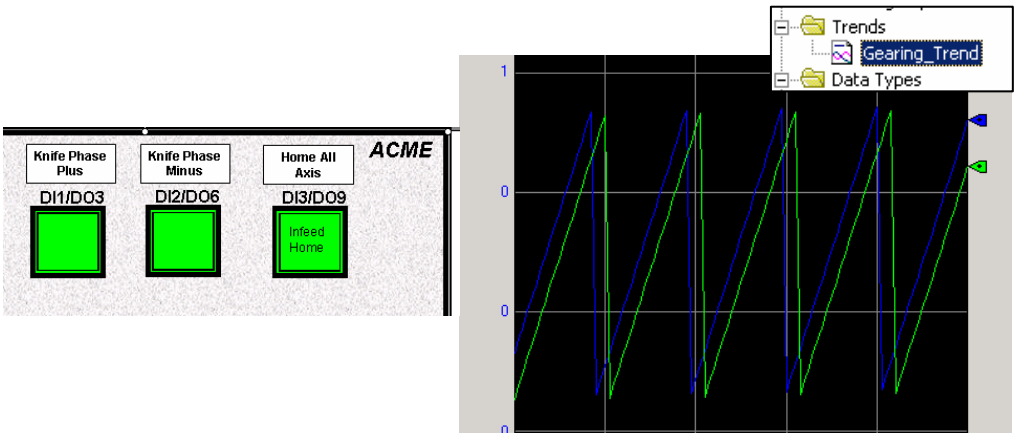


31. **Double Click** on the **Manual_Hot_Knife_Phase_Correction** Routine.



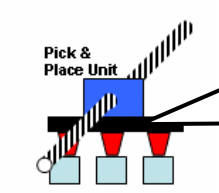
Four Rungs will display(2 shown above). They simply jog and stop the Knife in both both directions of travel. Select **Online→Rem Run**.

Enable(DI12) and **Home(DI3 and AXIS 2 HOME)** the axis. Turn on the **Infeed Belt On/Enable Gearing(DI14).** Open the **Gear** Trend→ **Run** .Note the phase relationship between the Knife and Infeed as you **Jog(DI1 & DI2)** the Knife in both directions. Close the trend.



Notice that the Knife (slave and left K6K) speeds up when you hold DI1 and slows down when you hold DI2.

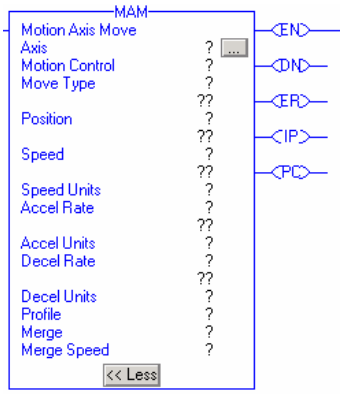
32. So far, we've run the machine in a continuous mode (Gearing). With Logix, we've eliminated costly downtime by synchronizing the **Knife** speed to the **Infeed** Belt speed with **Motion Axis Gearing**. Premier Packaging has decided to add an additional axis to control a pick and place unit. This is a single axis picker.



The operation is very simple. Every third box on the infeed belt trips a photo eye. The picker photo eye is examined in the **Pick_Place_State_Machine** Routine The routine commands the axis to move to a conveyor, activate the grippers(grabs packages), move back to the **Infeed** Belt and deactivate the gripper to place the packages on the belt.

Waits for the photo-eye(**DI8)** to start over.

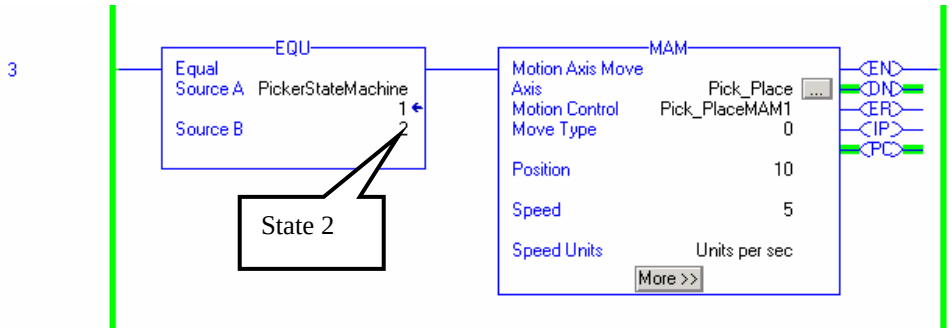
The Pick_Place State Machine routine uses the Motion Axis Move(MAM) Instruction to control the Picker. The Motion Axis Move (MAM) instruction moves a physical axis to a specified position (Absolute Move) or by a specified incremental distance (Incremental Move) at a specified speed, acceleration and deceleration.



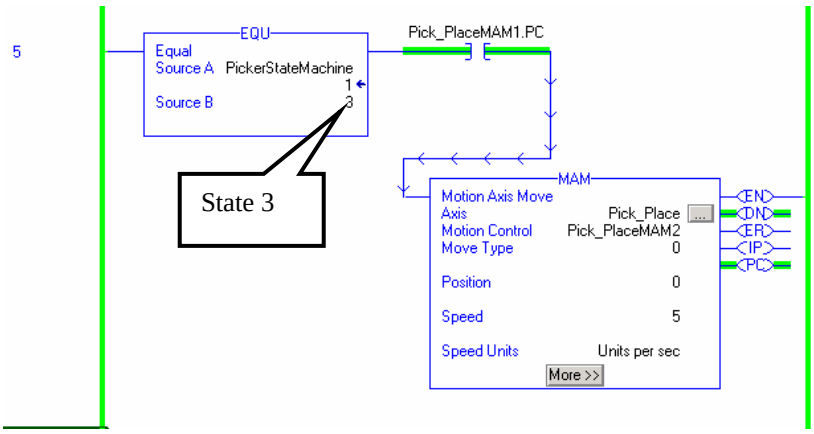
Operand:	Type:	Format:	Description:
Axis	AXIS_VIRTUAL AXIS_GENERIC AXIS_SERVO AXIS_SERVO_DRIVE	tag	Name of the axis to perform operation on.
Motion control	MOTION INSTRUCTION	tag	Structure used to access instruction status parameters.
Move type	UDINT	immediate or tag	The type of move operation you require. Select one of the following: 0 = Absolute Move 1 = Incremental Move 2 = Rotary Shortest Path Move 3 = Rotary Positive Move 4 = Rotary Negative Move 5 = Absolute Master Offset 6 = Incremental Master Offset
Position /Distance	REAL	immediate or tag	The value of the absolute command position to move to, or for incremental movement, the value of the distance to move from the current command position.
Speed	REAL	immediate or tag	The speed to move the axis in either % or Speed units.
Speed units	BOOLEAN	immediate	The units used to display the Speed value. Select either: 0 =units per sec 1 = % of maximum speed
Accel rate	REAL	immediate or tag	The acceleration rate of the axis in % or Acceleration units.
Accel units	BOOLEAN	immediate	The units used to display the Accel value. Select either: 0 = units per sec^2 1 = % of maximum acceleration
Decel rate	REAL	immediate or tag	The Deceleration rate of the axis in % or Deceleration units.
Decel units	BOOLEAN	immediate	The units used to display the Deceleration value. Select either: 0 = units per sec^2 1 = % of maximum acceleration
Profile	UDINT	immediate	The Velocity Profile to run for the move. Select either: 0 = Trapezoidal 1 = S-curve

33. Double Click and Open the **Pick_Place_State_Machine** routine.

There are two MAM instructions in the routine. The first MAM shown below is active in **State 2** and commands the Pick_Place Axis to 10 inches.

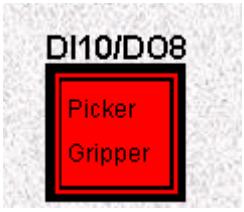


The second MAM, which commands the Pick_Place Axis back to 0, is active in **State 3**.



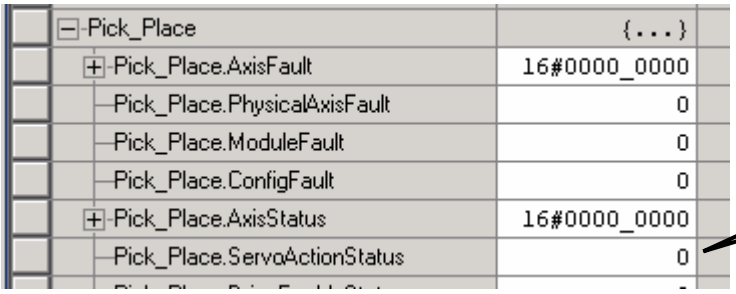
34. Press and release the **Pick_Place Photoeye Simulator(DI0)** button. and observe the **Motor_X** servo motor in the Logix demo case.

35. The motor will rotate 10 revs. In the positive direction, decelerate to a stop, turn on **DO08**, and then -10revs. And return to the 0 position and turn off **DO08**.

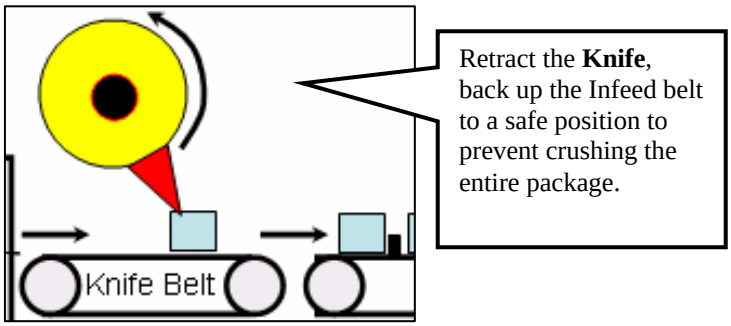


The pilot lights may be burned out on your demo box. To can observe the bit going true via being online to the ladder logic editor.

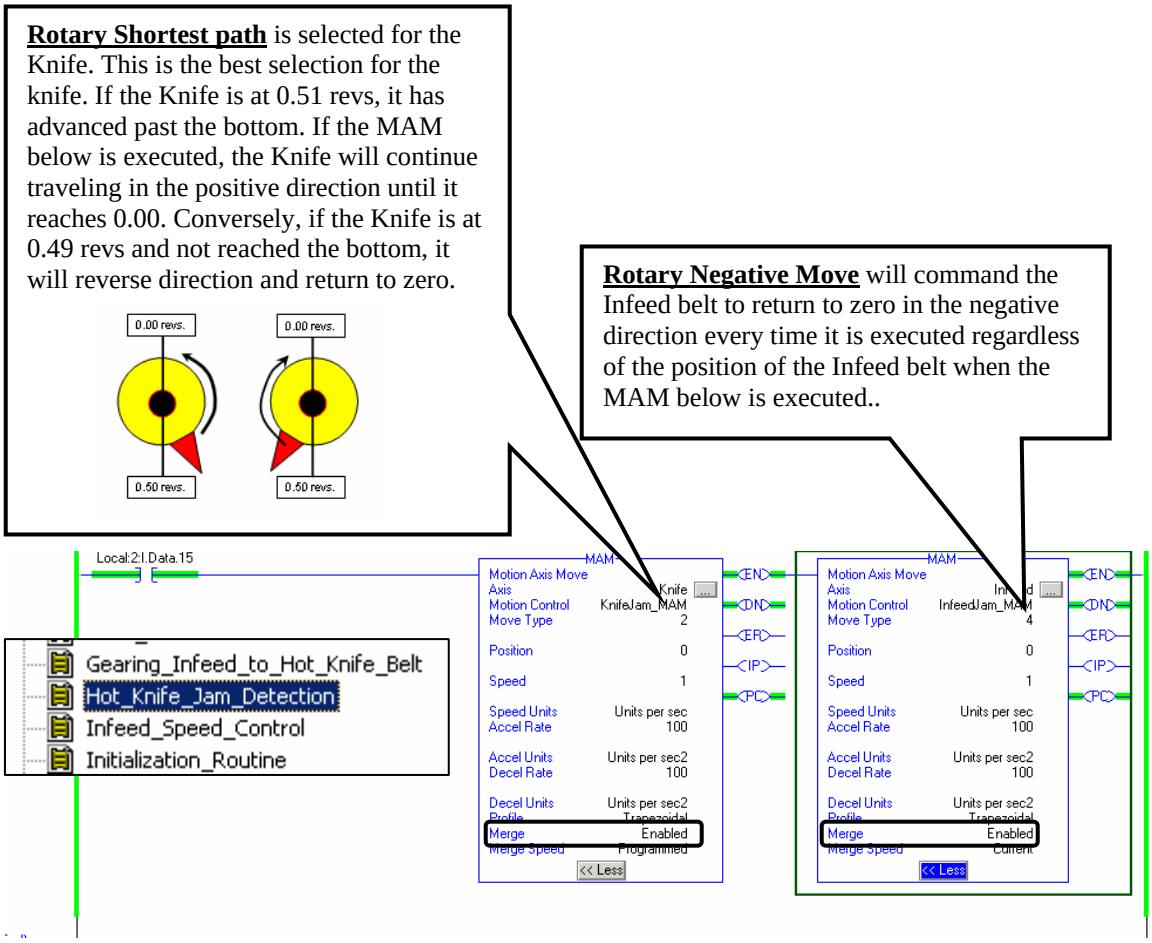
Using a State Machine model is useful in programming. In addition to providing an easy method of using the **MAM Instruction Structure (i.e. .IP, .PC bits)** bits to schedule sequential moves, it also allows for quick diagnosis of machine problems. Press and release the **Photoeye Simulator Button(DI0)**. Quickly turn off the **Drive Enable(DI12)** while the axis is moving in the positive direction. Upon examination of the program **Pick_Place State_Machine** program, you know immediately that the Pick & Place unit is hung up in **State 2** The Axis Structure will reveal that **Servo Action is off**. Turn on **Drive Enable(DI12).** This is a simplistic example. The power of State Machine becomes more apparent as machinery becomes more complex.



36. Periodically, a package jam occurs. When this occurs, the Knife and Infeed belt must disable gearing immediately, and move to a safe position. This is easily accomplished by a series with a MAM instruction with **Merge** enabled.



37. Double Click on the **Hot_Knife_Jam_Detection** routine.The program consist of two MAM instructions. Both have **Merge enabled**. A Motion instruction with Merge enabled simply cancels any other motion operation taking place (Gearing in our example) and executes its commanded motion until completion.



38. Turn **off** all Control Logix Demo Case **Selector Switches**. **Enable the Drive(DI12), Home the Axis(DI03 and AXIS 2 HOME),** turn on **Infeed On/Knife(DI14)** . Adjust **AI0** to a speed that allows you to easily observe the rotation of the axis. Turn on **Jam(DI15)** observe what happens. Turn off **Jam(DI15)** and **Infeed On/Knife(DI14).** Turn on **Infeed On/Knife(DI14)** to re-enable the axis in the gearing mode. Simulate a jam with the knife in different positions and observe. (To vary the position you must turn off DI12, DI14 and DI15, then you rotate the white markers on the two K6K axes. Then turn on the switches DI12, DI14 and DI15 in that order.)

This concludes the basic motion lab.