

Mechatronics
Flexible Manufacturing System

Servo Control

Job Sheets - Courseware Sample

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By the staff of Festo Didactic

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Safety and Common Symbols

The following safety and common symbols may be used in this manual and on the equipment:

Symbol	Description
	DANGER indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.
	WARNING indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
	CAUTION indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
	CAUTION used without the <i>Caution, risk of danger</i> sign  , indicates a hazard with a potentially hazardous situation which, if not avoided, may result in property damage.
	Caution, risk of electric shock
	Caution, hot surface
	Caution, risk of danger
	Caution, lifting hazard
	Caution, hand entanglement hazard
	Notice, non-ionizing radiation
	Direct current
	Alternating current
	Both direct and alternating current
	Three-phase alternating current
	Earth (ground) terminal

Safety and Common Symbols

Symbol	Description
	Protective conductor terminal
	Frame or chassis terminal
	Equipotentiality
	On (supply)
	Off (supply)
	Equipment protected throughout by double insulation or reinforced insulation
	In position of a bi-stable push control
	Out position of a bi-stable push control

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Preface

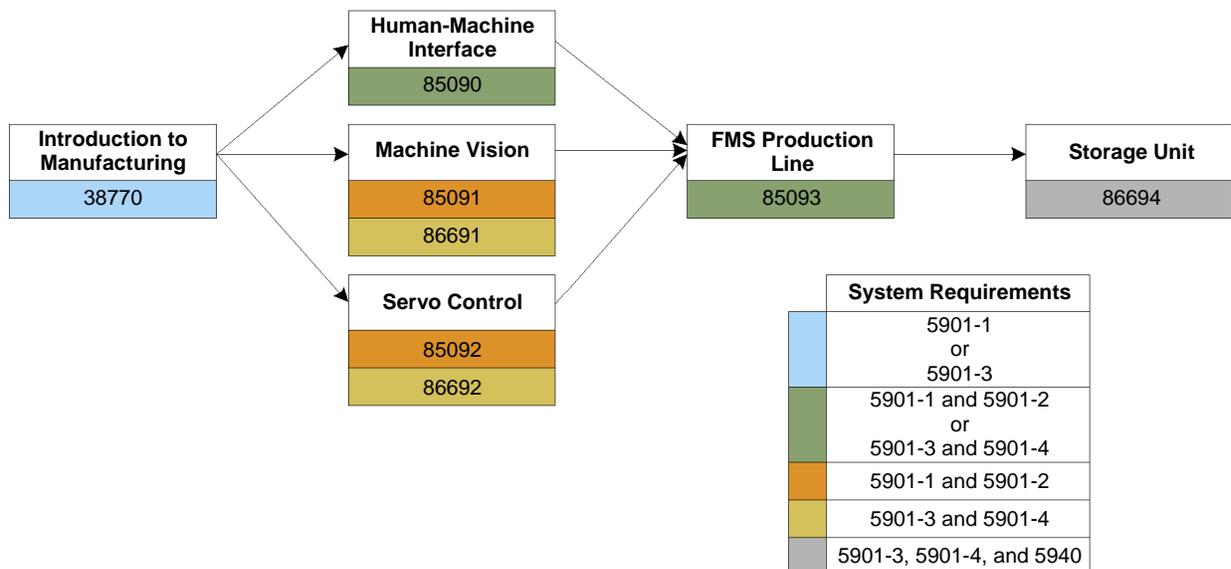
The Flexible Manufacturing System (FMS), Model 5901-1 or Model 5901-3, is a modular system that allows students to experience challenges commonly encountered in facilities. The system comes with the necessary equipment to familiarize students with basic manufacturing applications such as:

- operating a flat belt conveyor;
- feeding and sorting parts into containers;
- configuring and wiring sensors, buttons, indicator lights, and other devices;
- PLC programming;
- installing pneumatic equipment;
- troubleshooting.

The difference between Model 5901-1 and Model 5901-3 is in their Programmable Logic Controller. In Model 5901-1, the Allen-Bradley CompactLogix L32E (Model 5930-0) is used. With Model 5901-3, the Allen-Bradley CompactLogix L43 (Model 5930-A) is running the system. The L43 includes the functionalities of the L32E, but with integrated motion instructions.

The Flexible Manufacturing System (Advanced Applications), Model 5901-2 (add-on to 5901-01) or Model 5901-4 (add-on to 5901-3), is an add-on to the Flexible Manufacturing System. It allows students to create more sophisticated applications using the latest manufacturing technology such as: Servo Drive, Touch-Screen Operated Control, Machine Vision System, Bar Code Reader, and Optical Encoder. The fully automated Storage Unit option, Model 5940, is available as an add-on to Model 5901-3 and 5901-4.

The sequence in which the curriculum must be completed is shown below, along with the necessary equipment for each manual. The Introduction to Manufacturing manual must be completed first. Human-Machine Interface, Machine Vision, and Servo Control manuals can be completed independently, but are all prerequisites for FMS Production Line. Finally, Storage Unit requires knowledge of all the other subjects.



Preface

We invite readers of this manual to send us their tips, feedback, and suggestions for improving the book.

Please send these to did@de.festo.com.

The authors and Festo Didactic look forward to your comments.

About This Manual

The Job Sheets in this manual are designed for students already familiar with electrical wiring, basic PLC programming, and manufacturing processes. These topics are thoroughly covered in the reference textbook provided with the Flexible Manufacturing System. A careful reading of the reference textbook is highly recommended before proceeding with the Job Sheets.

As in the Introduction to Manufacturing manual, the difficulty and complexity increase with each Job Sheet. First, you will use direct commands of the Servo Drive using *RSLogix 5000* software. Secondly, you will gear the Servo Drive to the conveyor belt. Finally, you will use the Servo Drive to move the Part Feeder on the Linear Guide so that boxes are filled with marbles while the Flat Belt Conveyor is running.

For each Job Sheet, the required programs are provided on the Flexible Manufacturing System Resource Kit (student) DVD-ROM. Videos of some of the setups presented in the Job Sheets of this manual are also available on the DVD-ROM.

Required software

Make sure the following software is installed on your computer before using this manual.

- *RSLogix5000*
- *RSLinx*
- *RSNetworx for DeviceNet*

Safety considerations

Safety symbols that may be used in this manual and on the equipment are listed in the Safety Symbols table at the beginning of the manual.

Safety procedures related to the tasks that you will be asked to perform are indicated in each exercise.

Make sure that you are wearing appropriate protective equipment when performing the tasks. You should never perform a task if you have any reason to think that a manipulation could be dangerous for you or your teammates.

Flexible Manufacturing System Resource Kit DVD-ROM

This DVD-ROM contains configuration files, documentation, specialized software, and videos of the Flexible Manufacturing System in action. The configuration files are organized by application and corresponding device's type.



The content of the Flexible Manufacturing System Resource Kit DVD-ROM may have been copied by your instructor onto the computer used to control the Flexible Manufacturing System. If this is the case, ask your instructor where the content of the DVD-ROM can be found.

About This Manual

Systems of units

Units are expressed using the International System of Units (SI) followed by the units expressed in the U.S. customary system of units (between parentheses).

To the Instructor

You will find in this Instructor Guide all the elements included in the Student Manual together with the answers to all questions, results of measurements, graphs, explanations, suggestions, and, in some cases, instructions to help you guide the students through their learning process. All the information that applies to you is placed between markers and appears in red.

Accuracy of measurements

The numerical results of the hands-on exercises may differ from one student to another. For this reason, the results and answers given in this manual should be considered as a guide. Students who correctly performed the exercises should expect to demonstrate the principles involved and make observations and measurements similar to those given as answers.

Sample
Extracted from
the Job Sheets Student
and the Job Sheets Instructor

Gearing the Servo Drive to the Conveyor

OBJECTIVE Modify the PLC program to make the Part Feeder follow the Flat Belt Conveyor.

PROCEDURE **Set up and connections**

1. Perform the basic safety procedures listed in Appendix B of this manual.
2. Use Table 2 and Figure 32 to identify the new component used in this Job Sheet.

Table 2. New components used for Job Sheet 1.

Name	Model	Description/Function
Conveyor Optical Encoder	5928	Sensor used to determine the position and the direction of rotation of the servo motor.



Figure 32. Conveyor Optical Encoder.



Refer to the Equipment Utilization Chart in Appendix A of the manual to obtain the list of equipment required to complete this Job Sheet.

3. Connect the equipment as shown in the wiring diagram presented in Figure 33. Do not forget to connect the Conveyor Optical Encoder to the Servo Drive.

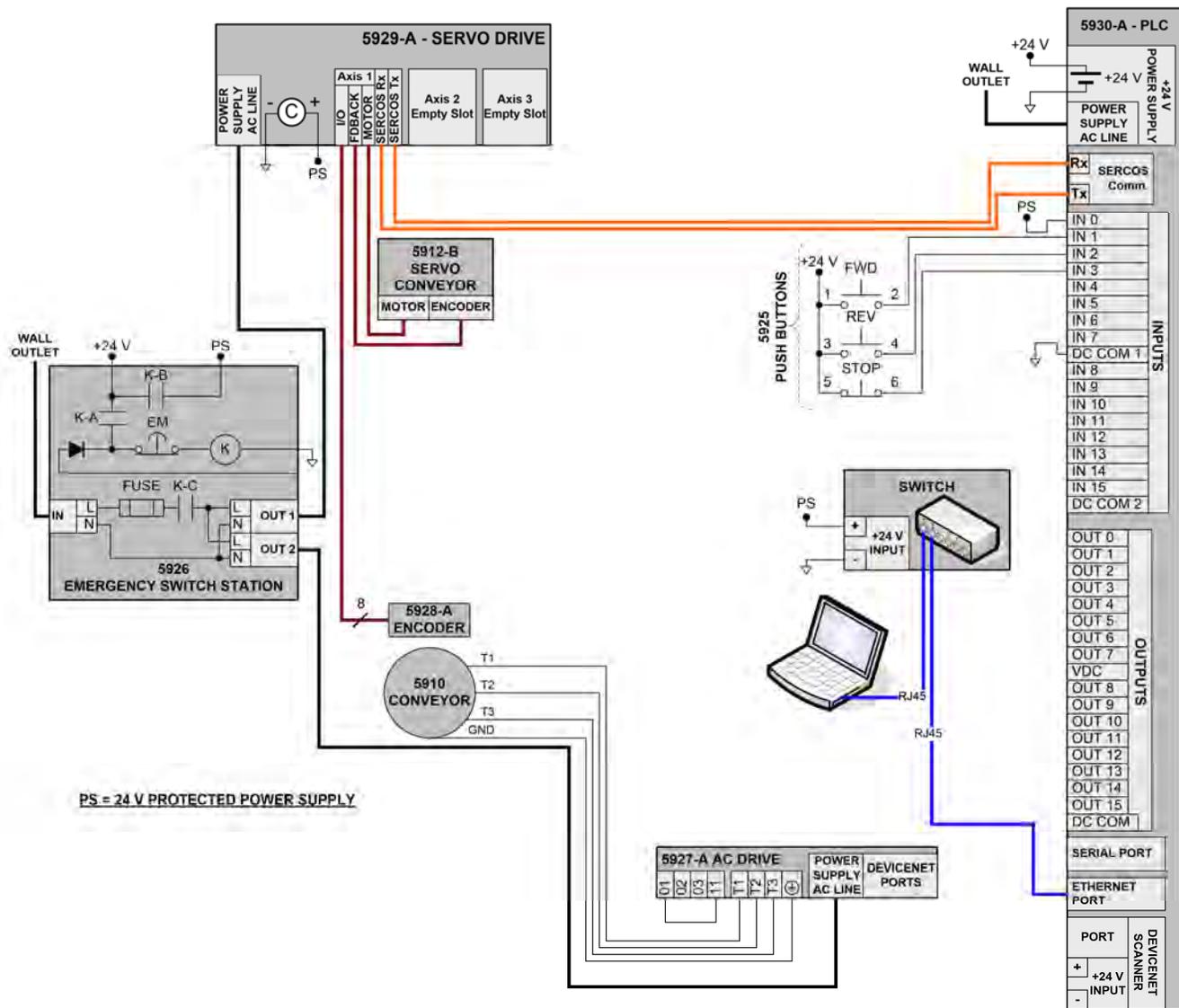


Figure 33. Gearing the Servo Drive to the Conveyor wiring diagram.

4. Once completed, the setup should look as shown in Figure 34.

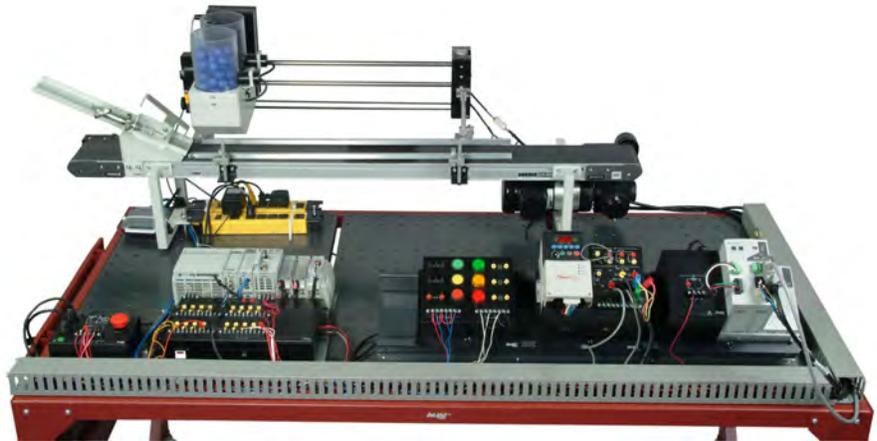


Figure 34. Gearing the Servo Drive to the Conveyor setup.

5. Turn on the computer, the switch, and the PLC.
6. Open *RSLinx* and verify that Ethernet communication with the PLC works correctly using RSWHo.

Addition of a second servo drive axis

7. Start *RSLogix 5000*. Open the PLC program for Job Sheet 2.
8. At this point, the *Motion Groups* ► *FMS* folder only contains *MPF*, the axis controlling the Mobile Part Feeder. In order to make the Part Feeder move at the same speed as the conveyor belt, you need to create a reference axis of type *AXIS_SERVO_DRIVE* for the conveyor. To do so, right-click on the *FMS* folder. In the contextual menu, select *New Axis* ► *AXIS_SERVO_DRIVE....*

- Give the name BC (Belt Conveyor) to this new axis and add a description (Figure 35). Keep the box at the bottom unchecked.

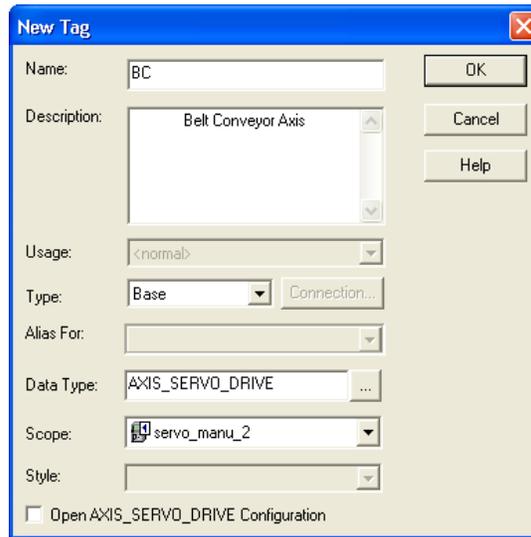


Figure 35. Axis description (BC).

- Open the BC *Axis Properties*. Figure 36 to Figure 41 are the recommended settings for the different *Axis Properties* tabs. Enter all these settings and click *Apply*.

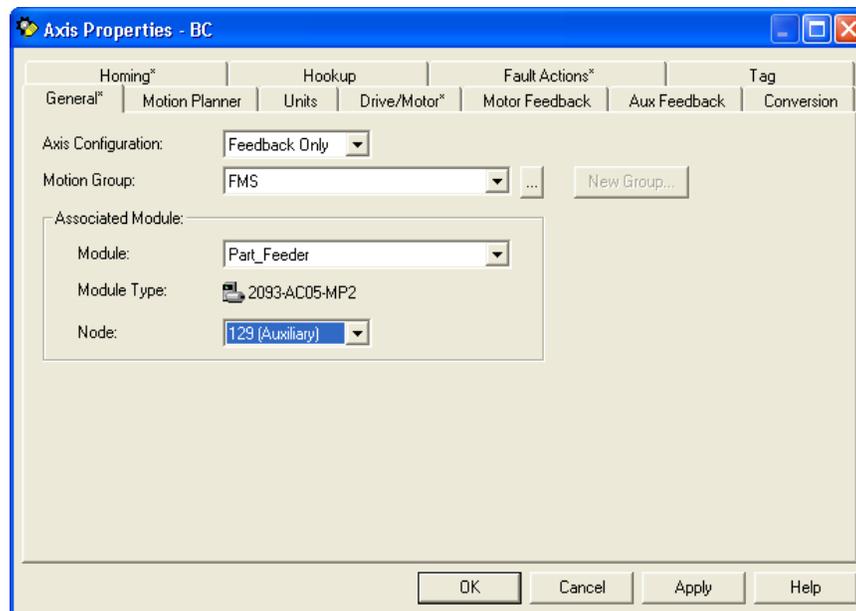


Figure 36. General (BC).

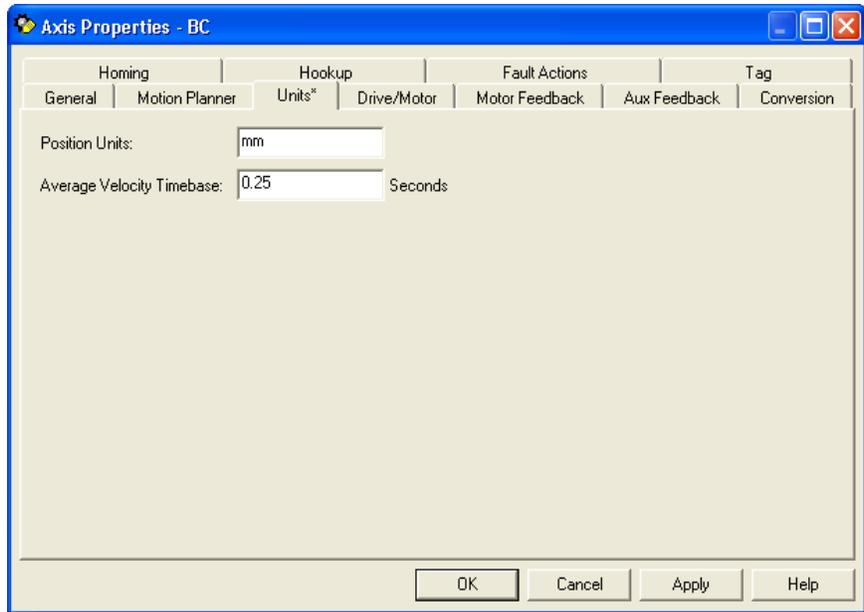


Figure 37. Units (BC).

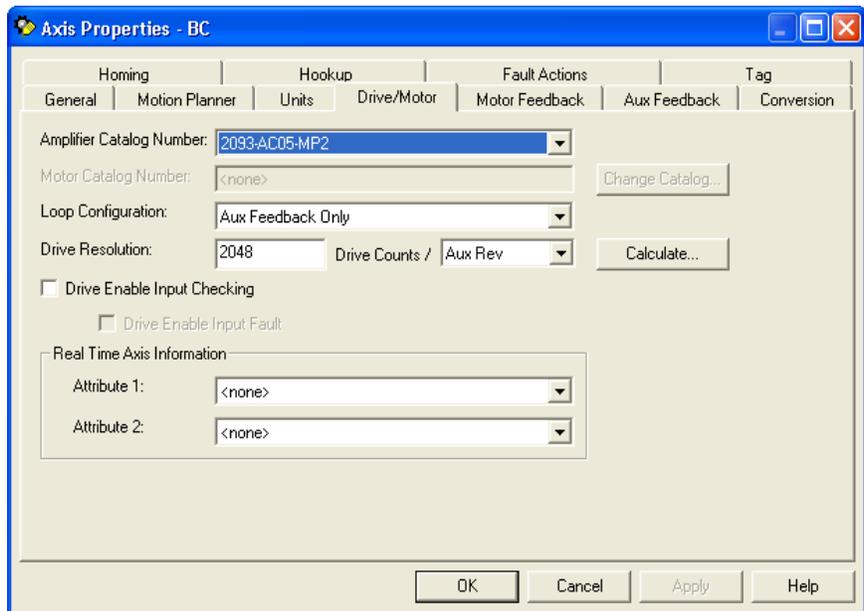


Figure 38. Drive/Motor (BC).

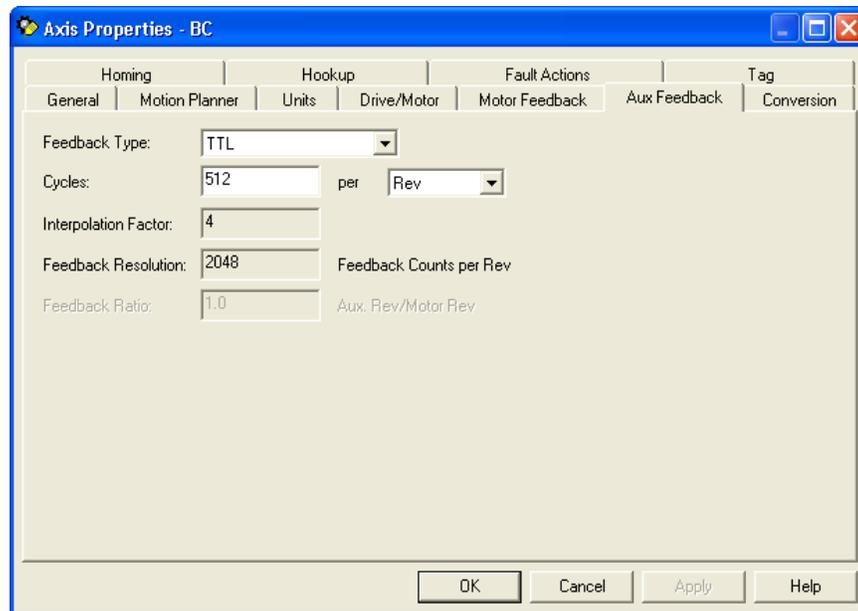


Figure 39. Aux Feedback (BC).

The *Conversion Constant* of the BC axis can be obtained by measuring the diameter of the roll to which the encoder is coupled with the conveyor belt on it (roughly 33 mm). This diameter times pi (π) gives the belt motion for each encoder rotation. This length corresponds to the 2048 counts produced by the encoder during a revolution.

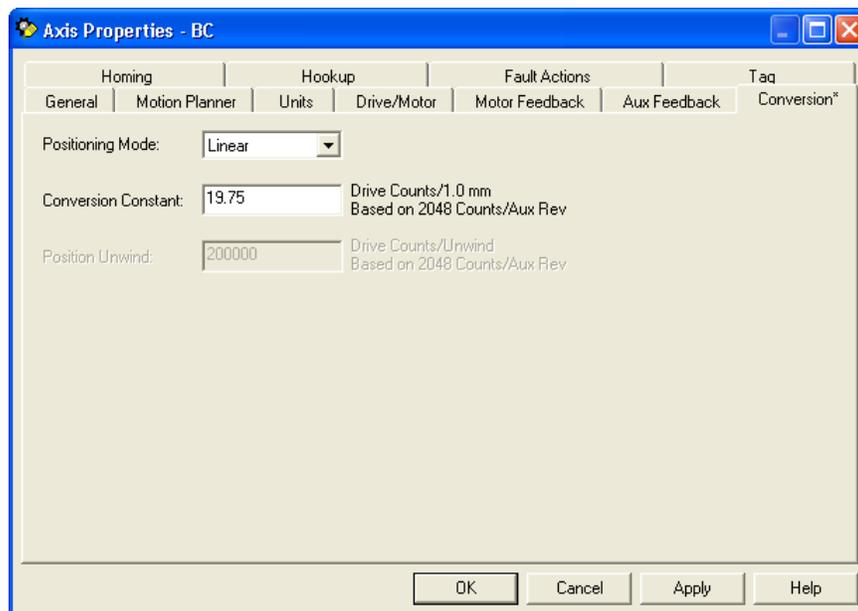


Figure 40. Conversion (BC).

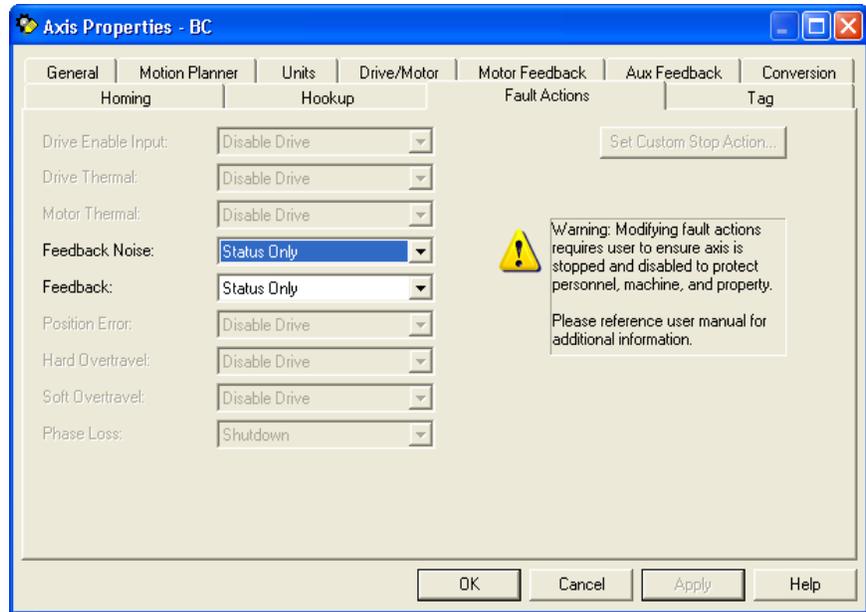


Figure 41. Fault Action (BC).

Examination of the PLC program

- Open the MainRoutine ladder program (*Tasks ▶ MainTask ▶ MainProgram ▶ MainRoutine*). You will note that rungs 0 to 3 are the same as for Job Sheet 1. Line 4 is already included and turns on the Servo Drive (MSO command) when the yellow push button is pressed and the station is on.

Add lines 5, and 6 of Figure 42. Rung 5 gears the slave axis MPF to the master axis BC if the green push button is pressed while the drive is on. Rung 6 stops the gearing if the red push button is pressed.

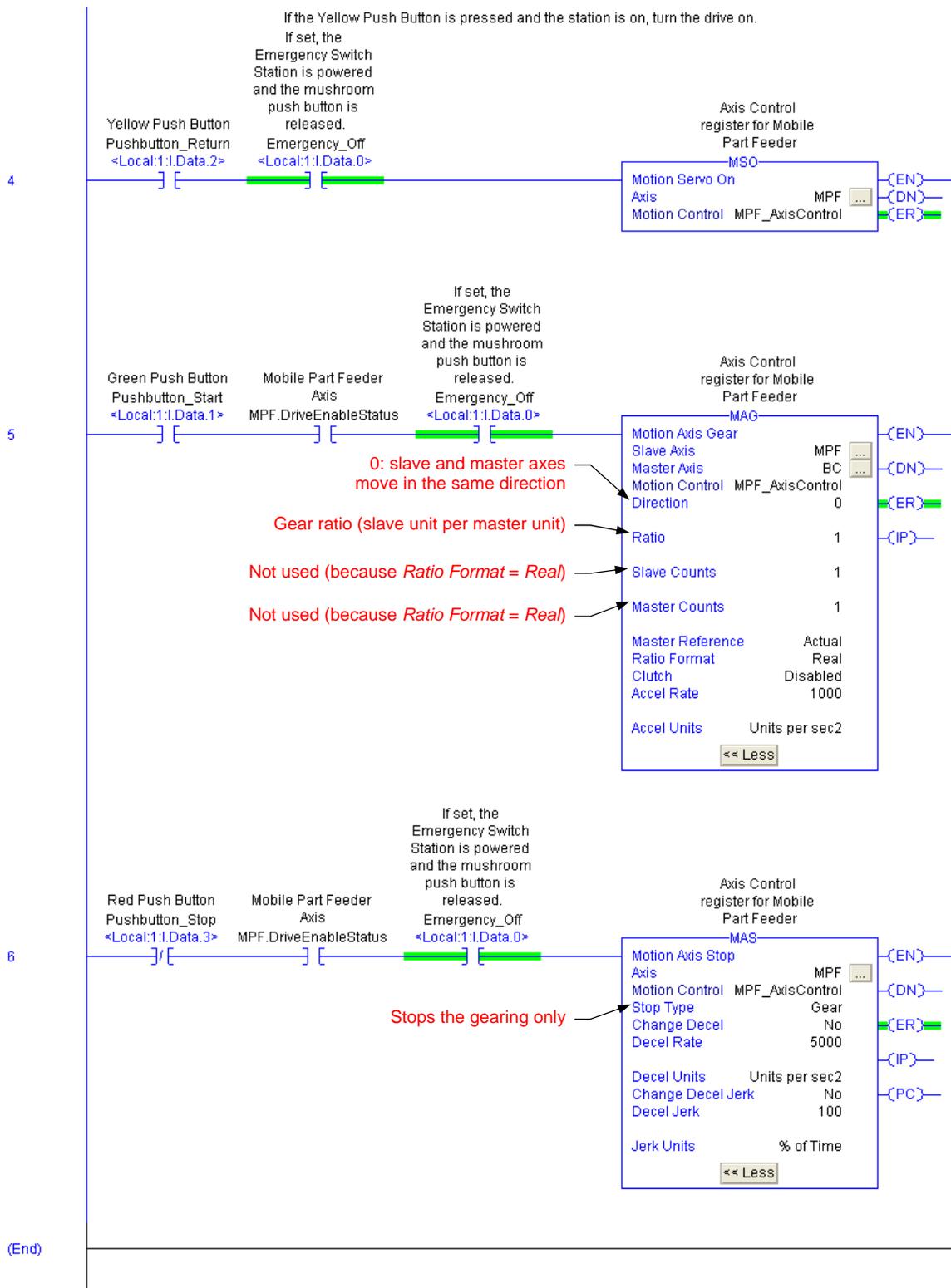


Figure 42. Job Sheet 2 program.

12. Make sure that the PLC key is in the *REM* position. Save your program under a new name and download it to the PLC.
13. Put the PLC to *Remote Run* mode.

Gearing the two drives

14. Move the Part Feeder by hand to the middle of the Linear Guide.
15. Press the red push button on the Indicator Light/Push-Button Station to power the station (refer to rung 3 of the MainRoutine). Make sure that the seven-segment LED indicator displays a “4” after the startup routine. This signifies that the drive is configured and active but not enabled. The operating state of the drive is then Axis ready (the Bus status LED on the drive is flashing green).
16. On the Indicator Light/Push-Button Station, press the yellow push button to enable the servo drive.
17. Start the AC Drive and set it for manual control, refer to the Familiarization with the AC Drive procedure given in Job Sheet 1 of the *Introduction to Manufacturing* manual (P/N 38770-20).
18. Use the AC Drive to start the Flat Belt Conveyor (forward direction). Set the Flat Belt Conveyor speed to less than half of its maximum value using the drive potentiometer.
19. On the Indicator Light/Push-Button Station, press the green push button to start the gearing.
20. The Part Feeder should move in the same direction and at the same speed as the Flat Belt Conveyor. Be sure to press the red push button to stop the Part Feeder before it reaches the end of the Linear Guide. Pressing the red push button stops the gearing.
21. Use the AC Drive to reverse the rotation direction of the Flat Belt Conveyor.
22. On the Indicator Light/Push-Button Station, press the green push button and observe the Part Feeder movement.

23. In which direction does the Part Feeder move?

The Part Feeder moves in the same direction as the Flat Belt Conveyor (reverse direction).

24. What happens to the Part Feeder if you change the speed of the Flat Belt Conveyor?

The Part Feeder automatically adjusts its speed to that of the Flat Belt Conveyor.

25. Put the PLC offline. On rung 5 of the MainRoutine, change the *Ratio* parameter of the *MAG* command to 2. Put the PLC back to *Run Mode* (you need to download the project to the PLC). Describe what happens when the two axes are geared and the conveyor is moving.

The Servo Drive is now moving twice as fast as the Flat Belt Conveyor.

26. Ask your instructor to check and approve your work.

Name: _____ Date: _____

Instructor's approval: _____