Mechatronics

Automatic Storage and Retrieval System
Flexible Manufacturing System

Job Sheets - Courseware Sample
86694-F0
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# Safety and Common Symbols

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

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="DANGER" /></td>
<td><strong>DANGER</strong> indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.</td>
</tr>
<tr>
<td><img src="image" alt="WARNING" /></td>
<td><strong>WARNING</strong> indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.</td>
</tr>
<tr>
<td><img src="image" alt="CAUTION" /></td>
<td><strong>CAUTION</strong> indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.</td>
</tr>
<tr>
<td><img src="image" alt="CAUTION" /></td>
<td><strong>CAUTION</strong> used without the <em>Caution, risk of danger</em> sign, indicates a hazard with a potentially hazardous situation which, if not avoided, may result in property damage.</td>
</tr>
<tr>
<td><img src="image" alt="Caution, risk of electric shock" /></td>
<td>Caution, risk of electric shock</td>
</tr>
<tr>
<td><img src="image" alt="Caution, hot surface" /></td>
<td>Caution, hot surface</td>
</tr>
<tr>
<td><img src="image" alt="Caution, risk of danger" /></td>
<td>Caution, risk of danger</td>
</tr>
<tr>
<td><img src="image" alt="Caution, lifting hazard" /></td>
<td>Caution, lifting hazard</td>
</tr>
<tr>
<td><img src="image" alt="Caution, hand entanglement hazard" /></td>
<td>Caution, hand entanglement hazard</td>
</tr>
<tr>
<td><img src="image" alt="Notice, non-ionizing radiation" /></td>
<td>Notice, non-ionizing radiation</td>
</tr>
<tr>
<td><img src="image" alt="Direct current" /></td>
<td>Direct current</td>
</tr>
<tr>
<td><img src="image" alt="Alternating current" /></td>
<td>Alternating current</td>
</tr>
<tr>
<td><img src="image" alt="Both direct and alternating current" /></td>
<td>Both direct and alternating current</td>
</tr>
<tr>
<td><img src="image" alt="Three-phase alternating current" /></td>
<td>Three-phase alternating current</td>
</tr>
</tbody>
</table>
Safety and Common Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Earth (ground) terminal" /></td>
<td>Earth (ground) terminal</td>
</tr>
<tr>
<td><img src="image2" alt="Protective conductor terminal" /></td>
<td>Protective conductor terminal</td>
</tr>
<tr>
<td><img src="image3" alt="Frame or chassis terminal" /></td>
<td>Frame or chassis terminal</td>
</tr>
<tr>
<td><img src="image4" alt="Equipotentiality" /></td>
<td>Equipotentiality</td>
</tr>
<tr>
<td><img src="image5" alt="On (supply)" /></td>
<td>On (supply)</td>
</tr>
<tr>
<td><img src="image6" alt="Off (supply)" /></td>
<td>Off (supply)</td>
</tr>
<tr>
<td><img src="image7" alt="Equipment protected throughout by double insulation or reinforced insulation" /></td>
<td>Equipment protected throughout by double insulation or reinforced insulation</td>
</tr>
<tr>
<td><img src="image8" alt="In position of a bi-stable push control" /></td>
<td>In position of a bi-stable push control</td>
</tr>
<tr>
<td><img src="image9" alt="Out position of a bi-stable push control" /></td>
<td>Out position of a bi-stable push control</td>
</tr>
</tbody>
</table>

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.
Table of Contents

Preface .............................................................................................................................. VII
About This Manual ......................................................................................................... IX

Job Sheet 1  Coordinate Axes ......................................................................................... 1
Job Sheet 2  Storage Positioning ..................................................................................... 19
Job Sheet 3  FMS Production Line with ASRS ............................................................... 29
Job Sheet 4  Command Order ......................................................................................... 37
Appendix A  Equipment Utilization Chart ..................................................................... 47
Appendix B  Safety Procedures ....................................................................................... 49
Preface

The LabVolt 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 5901-1) 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.
Sample

Extracted from

Job Sheets - Student
Command Order

**OBJECTIVE**
Modify the PLC and HMI programs to enable order preparation with the boxes stored in the Storage Unit. Manage and display alarms on the HMI.

**PROCEDURE**

**Order Preparation**

In this job sheet, the four cases of the Storage Unit top row are reserved to gather the order placed through the HMI (Figure 36). When the button *Prepare Order* is pressed, the traveling tray takes the desired (up to 4) products from where they are stored to the top row.

![Figure 36. HMI Command Order screen.](image)

Three types of alarms that can be generated during an order preparation will be handled during this job sheet. These alarms have the following tags:

- *Alarm_Back_Order*: some items requested are not available;
- *Alarm_Order_No_Space*: the top row is not empty;
- *Alarm_Order_Too_Big*: more than four items have been selected.

**System Setup**

1. Perform the basic safety procedures listed in Appendix B of this manual.

2. Make sure the equipment is connected as shown in the wiring diagram of Figure 6 or Figure 7 (Job Sheet 1), depending on your camera model.

Refer to the Equipment Utilization Chart in Appendix A to obtain the complete list of equipment required to complete this Job Sheet.
3. Make the pneumatic connections according to the diagram presented in Figure 37, but keep the Conditioning Unit inlet valve closed for now. You will not need pneumatics before step 17.

4. Be sure to fill the Part Feeder using marbles of two different colors. Use black marbles in the first hopper (the one close to the Part Feeder compact block I/O) and blue marbles in the second hopper.

   To keep marbles from getting stuck in the Part Feeder mechanism, do not overfill the hoppers.

5. Once completed, the setup should look as shown in Figure 8 (Job Sheet 1).

6. Turn on the computer, the router, the Programmable Logic Controller, and the Touch Screen Graphic Terminal.

7. Make sure the system is configured for Ethernet communication with the Flexible Manufacturing System. For details on the configuration of Ethernet
communication, refer to the Ethernet configuration procedure given in Job Sheet 2 of the *Introduction to Manufacturing* manual (P/N 38770-20). The Ethernet devices must have the addresses specified in Table 9.

**Table 9. Ethernet devices IP addresses.**

<table>
<thead>
<tr>
<th>NAME</th>
<th>MODEL</th>
<th>IP ADDRESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer</td>
<td>N/A</td>
<td>192.168.2.3</td>
</tr>
<tr>
<td>Programmable Logic Controller</td>
<td>5930</td>
<td>192.168.2.4</td>
</tr>
<tr>
<td>Touch Screen Graphic Terminal</td>
<td>5922</td>
<td>192.168.2.6</td>
</tr>
<tr>
<td>Machine Vision System</td>
<td>5920</td>
<td>192.168.2.8</td>
</tr>
</tbody>
</table>

**For DVT Vision System, Model 5920 only**

8. Open the file pertaining to your DVT camera model using DVT Intellect.

**DVT 515:**

`Camera_Settings.dvtisys`


**For Cognex In-Sight Vision System, Model 5920-1 only**

9. Table 10 shows the four pre-configured job files that are provided on the resource kit DVD-ROM for use with the Cognex In-Sight Explorer program. Make sure that they are all loaded on the camera memory by opening the *In-Sight Files* pane (View ➤ In-Sight Files). Open the job `WA_3BK1BL.job`. This job is made for white boxes and a recipe of 3 black marbles and 1 blue marble. Fine-tune the Machine Vision System and put the camera online in In-Sight Explorer. For details on the Machine Vision System and its configuration, refer to the *Machine Vision* manual (P/N 86691-20).

**Table 10. The four pre-configured job files for In-Sight Explorer.**

<table>
<thead>
<tr>
<th>Job Name</th>
<th>Box Color</th>
<th># Black Marbles</th>
<th># Blue Marbles</th>
</tr>
</thead>
<tbody>
<tr>
<td>RA_3BK1BL_job</td>
<td>Red</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>RA_1BK3BL_job</td>
<td>Red</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>WA_3BK1BL_job</td>
<td>White</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>WA_1BK3BL_job</td>
<td>White</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>
Modifying the PLC Program

The PLC program that you have modified in Job Sheet 3 still needs two changes to permit command order and management of the alarms:

1. A line must be added in `MainRoutine` to call the `Storage_Fill_Order`.

2. In the `Alarms_Low_and_High` routine you need to add three input references to the alarms that can be generated by the order preparation (refer to the `Order Preparation` section at the beginning of this Job Sheet).

10. Start `RSLogix 5000`. Open the PLC program with the modifications that you have made in Job Sheet 3 and save it under a new name.

11. Open `MainRoutine` and add a rung after rung 14. Enter the instructions shown in Figure 38 to enable the call of the `Storage_Fill_Order` routine by the HMI.

![Diagram](Image)

**Figure 38. Additional line in MainRoutine.**

12. Open the `Alarm_Low_and_High` routine. Add the three input references pertaining to order preparation alarms to the Boolean Or (BOR) block that generates a low alarm.

13. Save your PLC program and download it to the PLC. Put the controller to `Run` mode. For details on downloading programs, refer to the `Running the programs` procedure given in Job Sheet 2 of the `Introduction to Manufacturing` manual (P/N 38770-20).

Make sure RSLinx is running on your computer before trying to download the program to the PLC.
Modifying the HMI Program

The HMI program that you have used in Job Sheet 2 and Job Sheet 3 still needs two changes to permit command order and display alarms:

1. A button must be added in the Operator display to access the Command_Order display.

2. The three alarms set in the PLC program must be entered in the HMI Alarm Setup.

14. Open the FactoryTalk View Studio Application Manager and restore the application from archive file FMS_Storage_stu2_3_4.apa located on the Resource Kit DVD ROM. For details on the Touch Screen Graphic Terminal and on downloading applications to the Touch Screen Graphic Terminal, refer to the Human-machine Interface manual (P/N 85090-20).

15. Open this application in FactoryTalk View Studio and go to Graphics ► Displays ► Operator.

16. Add a Goto Display button called COMMAND ORDER (Figure 39). Set this button to open the Command_Order display.

⚠️ You can copy and paste the STORAGE VIEW button and modify the new button to save some time.

![Figure 39. Adding the COMMAND ORDER goto display button.](image-url)
17. Open **Alarms** ➤ **Alarm Setup** and click **Add** under the **Triggers** tab (Figure 40).

![Figure 40. Adding a trigger.](image)

18. Click on the **»** button under **Tag**.

![Figure 41. Trigger Tag.](image)
19. Select the *Alarm_Back_Order* tag (Figure 42) and click **OK**.

![Tag Browser](image)

*Figure 42. Tag browser (Alarm_Back_Order).*

20. Repeat steps 17 to 19 for the *Alarm_No_Space* and *Alarm_Order_Too_Big* tags.
21. Click on the **Messages** tab of the **Alarm Setup** window and add lines 20, 21, and 22 with a Trigger value of 1 and the messages shown in Figure 43. Click **OK**.

![Alarm Setup - IFMS_Storage_inst4](image)

**Figure 43. Adding alarm messages.**

22. Go to **Application ▶ Create Runtime Application** to create a runtime (.mer) application. Save all your changes.

23. Download this new runtime application to your Touch Screen Graphic Terminal using the **FactoryTalk View Studio Transfer Utility**.

24. Load and run this application on the Touch Screen Graphic Terminal.

**DeviceNet setup**

25. Press **INITIALIZE** on the HMI for more than one second to start the initialization routine. Once the initialization is completed, press **Skip Homing**.

26. Make sure the system is configured for DeviceNet communication with the two Storage Unit CompactBlock modules. For details on the configuration of the DeviceNet network, refer to the procedure given in Job Sheet 6 of the **Introduction to Manufacturing** manual (P/N 38770-20). You should be able to communicate with all DeviceNet modules of Figure 44 (Graph view in **RSNetWorx**).
Testing the system

Now that your PLC and HMI programs have been modified, it is time to test if the command order and alarms are working well.

27. Open the air inlet valve on the Conditioning Unit.

Be sure to adjust the pressure in the circuit downstream from the valve of the Conditioning Unit to 207 kPa (or 30 psi).

28. Place empty boxes with the color and bar code to fit the Current Production set on the HMI.

29. Re-initialize the system and perform axes homing from the HMI.

30. Start the production and make sure that the system is working well.

31. Stop the system. From the main HMI screen, press the Products button. Change the Current Production and restart production so that the Storage Unit contains different products. Stop the system when you have enough boxes stored.

Do not fill the top row of the Storage Unit or you will not be able to prepare an order!

32. On the HMI Operator screen, press COMMAND ORDER.

33. On the COMMAND ORDER screen, enter the number of boxes that you want and press Prepare Order. Verify that the correct order is placed on the top row. Remove these boxes and prepare a different order.
34. Test that your alarms work if you ask for more than 4 boxes or unavailable items, or if the top row is occupied.

35. Ask your instructor to check and approve your work.
Sample
Extracted from
Job Sheets - Instructor
Command Order

12. 

![Diagram of electrical logic]  

Figure 1. Modifications in the Alarms_Low_and_High routine.

35. The following points should be checked to assess the student’s work:

- The setup is wired according to the diagram presented in Figure 6 or Figure 7.
- The wiring ducts are used appropriately to maintain a tidy setup.
- A COMMAND ORDER button appears on the HMI Operator screen.
- Order preparation can be made from the HMI Command Order screen.
- The yellow indicator light illuminates and the ERROR message appears on the HMI if the requested items are not all present on the Storage Unit.
- The yellow indicator light illuminates and the ERROR message appears on the HMI if the top row of the Storage unit is not free.
- The yellow indicator light illuminates and the ERROR message appears on the HMI if more than 4 items are requested.