Mechatronics

Computer Integrated Manufacturing Applications

Courseware Sample

39468-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>
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<td><img src="image" alt="Caution, lifting hazard" /></td>
<td>Caution, lifting hazard</td>
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<td><img src="image" alt="Caution, hand entanglement hazard" /></td>
<td>Caution, hand entanglement hazard</td>
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<tr>
<td><img src="image" alt="Notice, non-ionizing radiation" /></td>
<td>Notice, non-ionizing radiation</td>
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<tr>
<td><img src="image" alt="Direct current" /></td>
<td>Direct current</td>
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<td><img src="image" alt="Alternating current" /></td>
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<td><img src="image" alt="Both direct and alternating current" /></td>
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<td><img src="image" alt="Three-phase alternating current" /></td>
<td>Three-phase alternating current</td>
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<tr>
<td><img src="image" alt="Earth (ground) terminal" /></td>
<td>Earth (ground) terminal</td>
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### Safety and Common Symbols

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

This document consists of tutorial exercises that allow you to implement the following applications:

• milling a part with the Lab-Volt CNC Mill, using the Lab-Volt CNC Mill Software.

• controlling the Lab-Volt Servo Robot and the Linear Slide, using the Lab-Volt RoboCIM 5250 software.

• controlling a manufacturing system that uses the Servo Robot and the CNC Mill.

• controlling the Lab-Volt Servo Robot and the Rotary Carousel, using the Lab-Volt RoboCIM 5250 software.

• controlling a manufacturing system that uses the Servo Robot, the Rotary Carousel, and the CNC Mill.

Each exercise consists of a DISCUSSION section describing the application to be implemented with the related drawings, followed by a practical section giving the steps to use to implement the application. The files required to perform each exercise (G and M part program and/or RoboCIM 5250 workspaces) can be found on the provided CD-ROM.

Before performing the exercises, it is recommended that you go through the following Lab-Volt manuals:

– Servo-Robot System, User Guide (part number 34175-E);
– Introduction to Robotics, Student Manual (part number 34175-0);
– Familiarization with the CNC Mill, Quick-Start Guide (part number 36783-E);
– CNC Mill Software, User Guide (part number 36189-E);

**Note:** For the sake of conciseness, the term “RoboCIM 5250 software” will be referred to as “RoboCIM” or “the RoboCIM software” for the remainder of the manual.
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Operating a manufacturing system that combines the milling process of
Exercise 1 and the robotics process of Exercise 4: the robot feeds parts
to the CNC Mill, which engraves a text on them. The robot then
transfers the milled parts onto the carousel and then into a storage box.
The Lab-Volt Servo Robot and CNC Mill can be interconnected, via the Robot Controller, to create automated work cells, ideal for familiarization with Computer-Integrated Manufacturing (CIM).

Many optional devices can be included in the Lab-Volt work cells to perform various processes: a gravity or pneumatic feeder, a linear slide, a rotary carousel, a conveyor, and various devices for the transfer or storage of parts.

For example, the following describes the operation of an automated work cell that uses a robot and a CNC Mill. (This work cell will be implemented in the third exercise of the manual.)

- The robot controller is programmed so that the robot picks a part from a feeder and moves it near the mill.

- The robot then verifies if the mill is ready to accept the part. If so, the robot places the part into the pneumatic vise of the mill and then withdraws from the mill area.

- The robot controller triggers the milling operation to start. The CNC part program, which has been downloaded into the mill's memory, is then carried out.

- Once the milling process is complete, the mill signals the robot controller that the part is milled. This causes the robot to remove the part from the vise of the mill and transfer it to a finished-goods location. A new cycle then begins.

The Simulation mode of the RoboCIM software and the Emulate function of the CNC Mill Software allow the student to test the operation of the implemented work cells before placing them into operation.

The program files required to perform the exercises in this manual are on the CD-ROM (part number 39557).
Sample Exercise
Extracted from
Student Manual
Control of the Lab-Volt Servo Robot and Rotary Carousel,
Using the RoboCIM 5250 Software

EXERCISE OBJECTIVE

When you have completed this exercise, you will be able to set up and operate a system that uses the Lab-Volt Servo Robot with the following accessories: the Rotary Carousel, Gravity Feeder, Location Tray, Location Plate, and Storage Box.

DISCUSSION

The Robotic system implemented in this exercise will operate as follows:

• The robot picks up a part from the Gravity Feeder and places it onto the Location Tray.

• The robot then grasps the part by its two other sides, moves it towards the Rotary Carousel, and places it on the carousel platter.

• The carousel platter is then rotated by 180°, carrying the part to a dwell location—which could be, for example, a process workstation for painting or welding the part.

Once a certain time delay has elapsed, the carousel platter is rotated by 180° in the reverse direction, bringing the part back to its initial location.

• The robot then removes the part from the carousel and transfers it into the Storage Box. A new cycle can begin.

Figure 4-1 shows the equipment setup for this system.

• The microswitch of the Gravity Feeder will be connected in such a way as to control the level of TTL input 1 of the Robot Controller.

The purpose of this switch is to prevent the robot from trying to grasp a part when the Gravity Feeder becomes empty:

– when the microswitch is activated by the presence of a part in the feeder, the level of TTL input 1 is set to logic state 0;

– when the microswitch is deactivated due to an empty condition, the level of TTL input 1 is set to logic state 1.

Therefore, the program you will run in the RoboCIM 5250 Software to control the system will contain the following command to verify if parts are available in the Gravity Feeder: "INPUT1 = 0".

• The Rotary Carousel will be connected to the Robot Controller through channel port 2 of the controller.
Control of the Lab-Volt Servo Robot and Rotary Carousel, Using the RoboCIM 5250 Software

Therefore, the following program commands will be used to control the rotation of the carousel:

– “RCHANNEL 2 = –180”: makes the Carousel platter rotate by 180° in one direction;

– “RCHANNEL 2 = 180”: makes the Carousel platter rotate by 180° in the opposite direction.

Figure 4-1. Location of the equipment on the work surfaces.
Control of the Lab-Volt Servo Robot and Rotary Carousel, Using the RoboCIM 5250 Software

Prerequisites

Before you begin the practical section of the exercise, make sure the following requirements are met.

1. The Robot Controller must be configured to detect the Rotary Carousel on Channel 2, using the hand-held terminal.

   Note: For detailed information on how to configure the Robot Controller for detection of the Rotary Carousel on a given channel, refer to Section 3, “Hand-Held Terminal, Configuration” of the Lab-Volt User Guide “Servo Robot System” (part number 34175-E).

2. The robot and Rotary Carousel must be calibrated according to the procedures found in Appendix D of the Lab-Volt User Guide “RoboCIM 5250 Software” (part number 37864-E).

3. You must have gone through the Application Example found in Section 7 of the Lab-Volt User Guide mentioned in step 2.

Procedure summary

In this exercise, you will test the provided program, 39468_EX4_**.rcw, in the Simulation mode, using the emulator of the RoboCIM 5250 software. This will allow you to see how the system operates before placing it into operation.

Next you will set up the equipment and run the RoboCIM program in the Control mode. You will observe the system operation by steps, and determine if points registered in the program need correction. If so, you will modify the coordinates of the points that need correction.

Finally, you will change the way in which the robot grasps parts and places them on the carousel platter by modifying the coordinates of specific points.

EQUIPMENT REQUIRED

- Servo Robot System, Model 5250 (Servo Robot, Robot Controller, Hand-Held terminal, Emergency Stop module, and Leads);
- Work Surfaces (two surfaces needed if Model 46604 is used, or four surfaces needed if Model 6309 is used);
- Spacer mounting brackets to mount and lock the work surfaces into place (Model 39035);
- Rotary Carousel, Model 5208-1;
- Square-Part Gravity Feeder, Model 5119;
- Location Plate, Model 38001;
- Storage Box, Model 38003;
- Location Tray, Model 38685;
- Square parts, [50 mm (2-in) wide, 50-mm (2-in) long, 12.7-mm (0.5-in) thick].
Control of the Lab-Volt Servo Robot and Rotary Carousel, Using the RoboCIM 5250 Software

PROCEDURE

Program Testing in the Simulation Mode

1. On the computer that hosts the RoboCIM software, launch this software. Open program 39468_EX4_**.rcw [in either millimeters (mm) or inches (in), according to your preference]. Ask your instructor for the file location if you cannot find it.

The RoboCIM main window appears, showing a 3D view of the equipment mounted on the work surfaces, as well as a list of points registered for the program, as Figure 4-2 shows.

![3D view of the equipment mounted on the work surfaces, and the list of points registered for the program.](image)

Figure 4-2. 3D view of the equipment mounted on the work surfaces, and the list of points registered for the program.

In the upper rightmost section of the RoboCIM main window, select the Program tab to display the Program window. Figure 4-3 shows the program 39468_EX4_**.rcw in both icon and text modes. (This program is the same for both millimeter or inch units.)
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Figure 4-3. RoboCIM program used to control the system: 39468_EX4**.rcw.
Control of the Lab-Volt Servo Robot and Rotary Carousel, Using the RoboCIM 5250 Software

2. Before testing the program in the Simulation mode, observe the location of each point registered in the browser of the Point Recorder panel.

   **Note:** To see the location of a point in the 3D view, click on the Point visibility button next to the point. To view the point coordinates, select the point by clicking on its name and then click on the Information button in the header section of the Point Recorder panel.

3. Run the program by steps in the Simulation mode: in the Toolbar of RoboCIM, make sure the Communication toolbar is set to Simulation (Simulation button in green, Control button in gray).

   In the Program window of RoboCIM, make sure the program is displayed in the icon mode. Run the program by steps by clicking on the button of the animation toolbar repeatedly, and fill in the sentences below.

   a. The end effector is first ________ (lowered/raised) toward the bottom of the (Location Tray/Gravity Feeder/Storage Box), then the gripper is ________ (closed/opened).

      **Note:** In the Simulation mode, the reduction of the speed as the end effector approaches an object is not visible.

   b. The program then verifies if parts are available in the Gravity Feeder, based on the signal sent by the microswitch of the Gravity Feeder to the Robot Controller (the program is at command "INPUT1 = 0").

      Since TTL Input LED 1 in the Controller Status panel of the RoboCIM main window is in ________ (red/green), a low level (OFF) is present at TTL input 1 and, therefore, ________ (a part/no part) is available in the Gravity Feeder.

      **Note:** When the program is run in the Simulation mode, a low (OFF) level is automatically simulated at TTL input 1 as long as the simulated number of parts in the feeder (as set in the RoboCIM Object window displayed upon selection of the Gravity Feeder) is not 0. Running the program many times will eventually cause the number of simulated parts to become null, and a high (ON) level to occur at TTL Input 1, indicating the absence of parts in the feeder and causing the program to become stuck at command INPUT1 = 0. In that case, set the Number of Parts field in the Object window for the Gravity Feeder to a non-null value (e.g. 5), to continue to run the program in the Simulation mode. Note that in the Control mode, the program will continue to run as long as parts are detected in the feeder, that is, even if the number of parts simulated by the program becomes null, because in that case, the program reads the actual signal provided by the microswitch of the Gravity Feeder.
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c. Therefore, the end effector picks a part from the ________, raises it above the work surface, and brings it right above the ________ (Gravity Feeder/Storage Box/Location Tray).

d. The speed is reduced, then the end effector places the part onto the ________. The gripper is ________ (closed/opened) to release the part.

e. The gripper is rotated by _____ (90°/45°) and then closed to grasp the part by its two ________ (other sides/opposite corners).

f. The part is raised above the work surface and moved, via an intermediate point, towards the ________ (Gravity Feeder/Rotary Carousel/Location Tray). It is brought right over one of the hollow squares of the carousel platter.

g. The part is placed in the hollow square of the carousel platter, then the gripper is ________ (closed/opened) and ________ (lowered below/raised over) the platter.

h. The platter of the Rotary Carousel is then rotated by 180°, which corresponds to program command ________, thus carrying the part to a dwell location.

i. After a dwell time of ________ seconds (program command ________), the Rotary Carousel is rotated by 180° in the reverse direction (program command ________), thus returning the part to the initial location.

j. The end effector is lowered toward the platter. It grasps the part by two opposite ________ (sides/corners), raises it above the platter and moves it, via an intermediate point, right over the ________ (Gravity Feeder/Storage Box/Location Tray).

k. The gripper is opened to drop the part into the box. The end effector then returns to its home position and a new cycle can begin.

l. When the Gravity Feeder becomes empty, the microswitch of this feeder becomes deactuated. This causes the program to stop at program command ________ (INPUT1 = 0/MOVETO = HOME). In the RoboCIM Controller Status panel, TTL Input LED 1 is in ________ (green/red), indicating that a high level (ON) is present at TTL input 1 (no part detected).
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4. Once you are familiar with the operation of the system, run the program continuously by clicking on the Run Continuously button and then the Execute button in the animation toolbar of the Program window. Then, stop program execution by clicking on the Stop button.

Program Testing in the Control Mode

Note: Before proceeding with the next steps, make sure that Channel 2 of the Robot Controller is assigned to the Rotary Carousel (CH 2 : CAROUSEL) and that the gripper is set to servo (GRIP : SERVO) in the configuration menu of the controller handheld terminal. [For detailed information on how to set the type of gripper used, and configure the controller for detection of the Rotary Carousel on a given channel, refer to Section 3, “Hand-Held Terminal, Configuration” of the Lab-Volt User Guide “Servo Robot System” (part number 34175-E)].

Moreover, make sure that the robot and Rotary Carousel have been calibrated according to the calibration procedures provided in Appendix D of the Lab-Volt User Guide “RoboCIM 5250 Software” (part number 37864-E).

CAUTION!

When you are working with moving equipment, make sure you are not wearing anything that might get caught in the equipment, such as a tie or jewelry. If your hair is long, tie it out of the way. Pay particular attention to keep your hands, other body parts, or anything attached to your body out of the mechanisms of the robot while the robot is moving.

Positioning the Equipment

5. Position the Robot, Rotary Carousel, Location Tray, Gravity Feeder, and Storage Box as shown in Figure 4-1.

Note: The equipment can be positioned in a way different than that illustrated in Figure 4-1. The important point is that the relative position of the objects (their position with respect to each other) on the work surfaces be the same as that shown in Figure 4-1.

Connecting the Equipment

6. Connect the equipment as shown in Figure 4-4. (The Rotary Carousel must be connected to channel 2 of the Robot Controller.)

As Figure 4-5 shows, connect the normally-open contact of the Gravity Feeder microswitch to TTL input 1 of the Robot Controller.
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Figure 4-4. Equipment connection.
Control of the Lab-Volt Servo Robot and Rotary Carousel, Using the RoboCIM 5250 Software

Emergency Stop Button

G 7. Make sure that the emergency stop button is released (in the upward position) and readily accessible during system operation.

Collisions may occur due to an improper calibration of the robot and Rotary Carousel or the erroneous positioning of the devices on the work surfaces.

Placing Parts in the Feeder

G 8. Place parts into the storage section of the Gravity Feeder.

Testing the Operation of the System by Steps

G 9. Turn on the Robot Controller and let the controller go through its initialization process.

G 10. In the Toolbar of the RoboCIM main window, set the Communication toolbar to Control [in which case the toolbar buttons will become gray (Simulation) and red (Control)].
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**Note:** If the hard home positioning of the robot and Rotary carousel have not been done yet, a dialog box will appear to indicate that this will be performed. Click [Do hard home 📦] to accept and close the box.

☐ 11. You will now run the program by steps. Before you do so, read the **CAUTION** below.

**CAUTION!**

Be sure to watch the robot operate closely, and be ready to press on the emergency stop button. If the robot is in danger of colliding with an obstacle, press on the emergency stop pushbutton, which will cause all the system operations to be halted, and the red LED indicator next to this button to turn on. Thereafter, use the following steps to return the system into operation:

- Release the emergency stop pushbutton by using the required key, which will cause the red LED indicator next to this button to turn off.
- In the RoboCIM software, select Release Emergency Stop from the Controller menu of the RoboCIM menu bar.
- Select the Motion tab of RoboCIM to display the Motion window.
- In the Cartesian or Articular Coordinates panel of the Motion window, carefully move the end effector of the robot, using the arrow keys, in order to withdraw the end effector to a safe area so that no collisions will occur when the robot is returned to the soft home position.
- If a square part is currently gripped by the end effector, open the gripper to release it.
- Return the robot to the soft home position by selecting Soft Home from the Motion menu of the RoboCIM menu bar.
- In the Toolbar of the RoboCIM main menu, set the Communication toolbar to Simulation.
- Remove any square part on the equipment setup that is not located in the Gravity Feeder or the Storage Box. Be sure that there is no part left in the Location Tray or Rotary Carousel.
- Correct the problem. Collisions may occur due to an improper calibration of the robot and Rotary Carousel or the erroneous positioning of the devices on the work surfaces.
- Once the problem has been corrected, set the Communication toolbar of RoboCIM to Control and test the operation of the system as directed in step 12.

☐ 12. Run the program by steps: click on *Execute step by step* 🔄 in the RoboCIM Program window.

Observe the action performed by the robot for each command. While observing the system operation, determine if points registered in the program will need a correction of their coordinates: for example,

- when placed in the Location Tray, the part must sit correctly in the hollow square area of the tray.
Control of the Lab-Volt Servo Robot and Rotary Carousel, Using the RoboCIM 5250 Software

- when grasped by the two other sides, the part should be grasped at equal heights.
- when placed on the carousel platter, the part must sit correctly in the hollow square area.
- once it has been rotated by the carousel, the part should be grasped at equal heights.

**Note:** It is normal for the coordinates of some points registered in the initial program to require some correction, due to backlash between the gears of the transmission coupled to the motors that drive the robot. Thus, because of the backlash, the end effector of the robot, when moved to a registered point, may not exactly be at the physical location specified for that point. Therefore, the coordinates of the registered point might require some correction, for the end effector to actually go to a precise location.

To correct the coordinates of a point, follow the procedure below.

a. Using the **Execute step by step** command in the RoboCIM Program window, move the end effector by steps until it reaches the point that needs correction and the program command corresponding to that point `[MOVETO ‹Point Name›]` becomes highlighted in RoboCIM.

(For example, if, when placed on the Location Tray, the part does not sit correctly in the hollow square area of the tray, move the end effector to point TRAY_IN, that is, until the highlighted command is MOVETO TRAY_IN).

b. Select the **Motion** tab of RoboCIM to display the Motion window. In the header section of this window, select either the **Cartesian Coordinates** or **Articular Coordinates** tab, depending upon the mode of coordinates you want to display to make the correction. (Figure 4-6, for example, shows the Motion window when the Cartesian Coordinates panel is selected.)
Control of the Lab-Volt Servo Robot and Rotary Carousel, Using the RoboCIM 5250 Software

Figure 4-6. The Motion window (with Cartesian Coordinates panel displayed).

c. In the Cartesian Coordinates or Articular Coordinates panel, click on the Move To button to display the Cartesian Move To or Articular Move To dialog box. This box shows the current coordinates of the end effector. (Figure 4-7, for example, shows the Cartesian Move To dialog box with the current coordinates of a point to be modified.)
d. In the Cartesian or Articular Move To dialog box, modify the values of the coordinates that need correction, clicking on the MOVE TO now! button after each modification to see the effect it has on the position of the end effector, until the end effector is properly positioned. (If you want, you can switch the display between the Cartesian and Articular Move To dialog boxes to achieve proper positioning of the end effector.)

Note: You can also modify the values of the coordinates by using the arrows of the Cartesian Coordinates or Articular Coordinates panel.

e. Once the end effector is properly positioned, click on the Record button of the Point Recorder panel, which will cause a dialog box to appear, prompting you to enter a name. Enter the name of the point being modified (as recorded in the Point Recorder panel, and using the same character case) and then click OK. This will cause another dialog box to appear, asking you if you want to replace the old point (Figure 4-8, for example, shows this box when the coordinates of point TRAY_IN have been modified). Click on Replace, which will save the point with the modified coordinates.

Note: To save a point with the new modified coordinates, make sure, when entering the point's name, that the case of each typed character matches that of each character of the point's name, as recorded in the Point Recorder panel.
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Figure 4-8. Saving the newly modified coordinates for a point.

f. Close the Cartesian and Articular Move To dialog box and save the program with the modified point coordinates.

g. Continue to run the program by steps until the last command is reached.

h. Run the program again to see if the point coordinates are correct, since they might need further correction.

* 13. Once the registered points are all correct, return the robot to the Home position. You can then run the program continuously by clicking on the **Run Continuously** button and then the **Execute** button in the animation toolbar of the **Program** window. Then, stop program execution by clicking on the **Stop** button.

* 14. Experiment further with modification of the point coordinates:

  a. Place the RoboCIM software in the **Simulation** mode.

  b. Modify the coordinates of the points listed below so that the parts, once placed in the Location Tray, will be grasped by a pair of opposite **corners**, then placed in the hollow square of the carousel platter with the proper orientation, and, once rotated by the carousel, grasped by a pair of **opposite corners** for their transfer into the Storage Box.

     - TRAY_OUT
     - TRAY_OUT_UP
     - INTER
     - CAR_UP
     - CAR_IN
     - CAR_OUT

     **Hint:** For each point, access the Cartesian Coordinates panel and increase or decrease the Roll by about 45°.

  c. In the **Simulation** mode, test the program with the modified coordinates for the six points.
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d. Once the program executes properly, place the RoboCIM software in the Control mode. Verify that the system operates properly, and readjust the coordinates of the points that need correction, if any. Once the system operates properly, save the program as 39468_EX4_Experiment_**.rcw.

☐ 15. Place the RoboCIM software in the Simulation mode, then turn off the Robot Controller.

CONCLUSION
In this exercise, you set up and operated a system that made the robot pick up parts from a gravity feeder and place them on a rotary carousel. The carousel was rotated by 180° and then allowed to dwell to simulate the processing of the parts at a workstation. The carousel was then rotated by 180° in the opposite direction to return the parts to their original location. The parts were then transferred into a storage box.

REVIEW QUESTIONS
1. Which two lines of the RoboCIM program made the carousel rotate by 180° in one direction and then the other?

2. In this exercise, what was the logic state of the TTL input signal provided by the Gravity Feeder microswitch when parts were present in the Gravity Feeder? When the feeder was empty?

3. At what command did the RoboCIM program stop when the Gravity Feeder became empty, causing the system operation to stop? Explain.

4. Which program line was used to make the rotary carousel dwell at a location for 5 seconds?
5. Given a MOVETO command used to make the robot grasp a part by two opposite sides, how can the cartesian coordinates of the point associated with this command be modified to make the robot grasp the part by the two other sides instead? By two opposite corners?
Sample
Extracted from
Instructor Guide
EXERCISE 4  CONTROL OF THE LAB-VOLT SERVO ROBOT AND ROTARY CAROUSEL, USING THE ROBOCIM 5250 SOFTWARE

ANSWERS TO PROCEDURE STEP QUESTIONS

☐ 3. a. The end effector is first lowered toward the bottom of the Gravity Feeder, then the gripper is opened.

b. Since TTL Input LED 1 in the Controller Status panel of the RoboCIM main window is in red, a low level (OFF) is present at TTL input 1 and, therefore, a part is available in the Gravity Feeder.

c. Therefore, the end effector picks a part from the Gravity Feeder, raises it above the work surface, and brings it right above the Location Tray.

d. The speed is reduced, then the end effector places the part onto the Location Tray. The gripper is opened to release the part.

e. The gripper is rotated by 90° and then closed to grasp the part by its two other sides.

f. The part is raised above the work surface and moved, via an intermediate point, towards the Rotary Carousel. It is brought right over one of the hollow squares of the carousel platter.

g. The part is placed in the hollow square of the carousel platter, then the gripper is opened and raised over the platter.

h. The platter of the Rotary Carousel is then rotated by 180° in one direction, which corresponds to program command RCHANNEL 2 = –180°, thus carrying the part to a dwell location.

i. After a dwell time of 5 seconds [program command DELAY (s) = 5], the Rotary Carousel is rotated by 180° in the reverse direction (program command RCHANNEL 2 = 180°), thus returning the part to the initial location.

j. The end effector is lowered toward the platter. It grasps the part by two opposite sides, raises it above the platter and moves it, via an intermediate point, right over the Storage Box.

k. The gripper is opened to drop the part into the box. The end effector then returns to its home position and a new cycle can begin.

l. When the Gravity Feeder becomes empty, the microswitch of this feeder becomes deactuated. This causes the program to stop at program command INPUT1 = 0. In the RoboCIM Controller Status panel, TTL Input LED 1 is in green, indicating that a high level (ON) is present at TTL input 1 (no part detected).
ANSWERS TO REVIEW QUESTIONS

1. The program lines "RCHANNEL 2 = –180" and "RCHANNEL 2 = 180".

2. When parts were present in the feeder, the Gravity Feeder microswitch was activated, causing TTL input 1 to be at logic state 0. When the Gravity Feeder was empty, the microswitch was deactivated, causing TTL input 1 to be at logic state 1.

3. When the feeder became empty, the RoboCIM program stopped at command INPUT1 = 0 (OFF), because a high (ON) TTL logic level was present at TTL input 1.

4. The program command "DELAY (s) = 5"

5. To make the robot grasp the part by the two other sides, the Roll is increased or decreased by 90°.

   To make the robot grasp the part by two opposite corners, the Roll is increased or decreased by 45°.

EXERCISE 5  CONTROL OF A MANUFACTURING SYSTEM THAT USES THE LAB-VOLT SERVO ROBOT, CNC MILL, AND ROTARY CAROUSEL

ANSWERS TO PROCEDURE STEP QUESTIONS

☐  4. a. The end effector is first lowered toward the bottom of the Gravity Feeder and the gripper is opened.

   b. Since TTL Input LED 1 in the Controller Status panel of the RoboCIM main window is in red, a low or "OFF" level is present at TTL input 1, indicating the presence of a part in the feeder.

   c. Therefore, the end effector picks a part from the feeder and then moves it right above the Location Tray, places the part on it, releases the part, and then grasps it by opposite corners.

   e. The end effector places the part in the pneumatic vise of the CNC Mill, and then retracts out of the mill area, pausing near the open (right-hand) side of the mill (command MOVETO = MACHINING).

   i. At that point, the program makes the Robot controller send a low-(OFF) level signal to the CNC Mill to indicate that the milled part has been withdrawn from the mill: therefore, command OUTPUT1 (CNC1) = O is