Mechatronics

Introduction to Robotics

Courseware Sample

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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	**DANGER** indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.
⚠ WARNING	**WARNING** indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
⚠ CAUTION	**CAUTION** indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
CAUTION	**CAUTION** used without the *Caution, risk of danger* 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

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.

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Introduction

The Lab-Volt Robot Systems, Models 5100 and 5150, provide complete and affordable training in the programming and operation of industrial style robots. Through the curriculum and hands-on experience gained in working with these systems, students learn to create automated work cells ideal for flexible manufacturing systems (FMS) and computer-integrated manufacturing (CIM).

The precision-built joined arm represents an important step forward in automation and handling. A stepper motor located in the base of the unit provides horizontal rotation while five additional stepper motors located in the shoulder provide precision movements of specialized components. The robot has five axes of rotation plus a gripper and is able to use all joints simultaneously to perform a programmed move sequence. Movement of the elbow joint, and gripper mechanisms, is accomplished by cables and belts through a series of gears and belt-driven pulleys.

The base of the unit includes one connector for an external stepper motor which can be used for further experimentation, such as operating a carousel. The robot has external device control connections. Accessory devices include a Magnetic Gripper. Feedback lines are included among the unit output lines to enable the robot to operate in a wait state via an external sensor. The included File Transfer software allows point programs to be stored and retrieved from a PC through a standard serial port

Courseware Outline

INTRODUCTION TO ROBOTICS

Exercise 1 Introduction and Familiarization

Introduction to the Lab-Volt Robot Training System. Installation, connection, operation, and experiment with the equipment.

Exercise 2 Programming

Introduction to the various terms used in the Robotics field. Creation and saving a program to control the Articulated-Arm Robot operation.

Exercise 3 Program Editing and Control Instructions

Program editing and modification. Introduction to control instructions, and stepper motors.

Exercise 4 Industrial Application - Simulation 1

Creation of a program that simulates a spot-welding application.

Exercise 5 Industrial Application - Simulation 2

Creation of a program that simulates a painting application.

Exercise 6 Industrial Application Simulation Using a Belt Conveyor

Introduction to the Belt Conveyor, Model 5118. Direct and external control of the conveyor. Detection of objects using a limit switch.

Exercise 7 Industrial Application Simulation Using a Rotary Carousel

Introduction to the Rotary Carousel. Experiment and creation of a program that simulates a galvanizing process.

Exercise 8 Industrial Application Simulation Using a Gravity Feeder

Introduction to the Gravity Feeders, Models 5119/5121. Experiment and creation of a program that simulates a quality control station.

Courseware Outline

INTRODUCTION TO ROBOTICS

Exercise 9 Industrial Application Simulation Using a Pneumatic Feeder

Introduction to the Pneumatic Feeders, Models 5122/5142. Experiment and creation of a program that simulates an industrial application.

Appendices

A Equipment Utilization Chart
B Connections
C Movement and Control Instructions

Sample Exercise

Extracted from

Introduction to Robotics

Exercise 6

Industrial Application Simulation Using a Belt Conveyor

EXERCISE OBJECTIVE

In this exercise, you will learn how to use the Belt Conveyor, Model 5118. You will experiment with its various features.

You will use the Belt Conveyor to move objects, and you will detect these objects with a limit switch mounted on the conveyor chassis. The output signal of the limit switch will be used to trigger a control instruction in a program.

You will experiment with the TTL outputs to control the operating parameters of the Belt Conveyor.

DISCUSSION

Robots work with other pieces of equipment called part feeders. There are various types of part feeders. The gravity and pneumatic feeders, rotary carousels and belt conveyors are examples of part feeders.

The Belt Conveyor of your training system is shown in Figure 6-1. It can be operated either by switches mounted on the control panel, or by control signals provided via the TTL outputs on the base of the Articulated-Arm Robot.

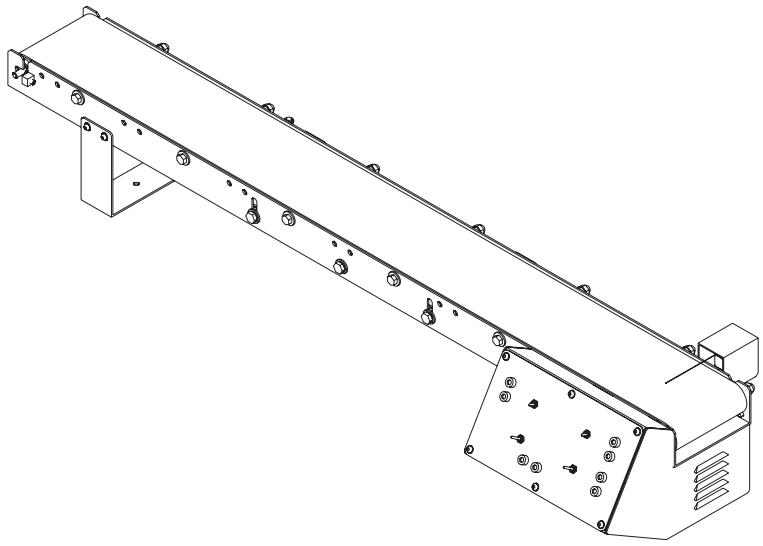

Figure 6-1. Belt Conveyor, Model 5118.

Industrial Application Simulation Using a Belt Conveyor

The operating parameters of the Belt Conveyor that can be controlled are the motor power (MOTOR), stepper motor clock signal (CLOCK), belt direction (DIRECTION), and speed (SPEED).

Direct Control

The control panel of the Belt Conveyor is shown in Figure C-2. The MOTOR switch controls the operation of the motor. To start the motor, the MOTOR switch must be set at ENGAGE and the CLOCK switch must be set at ENABLE to provide the required clock signal to the motor. The motor can be stopped by setting the MOTOR switch at DISENGAGE and/or the CLOCK switch at DISABLE.

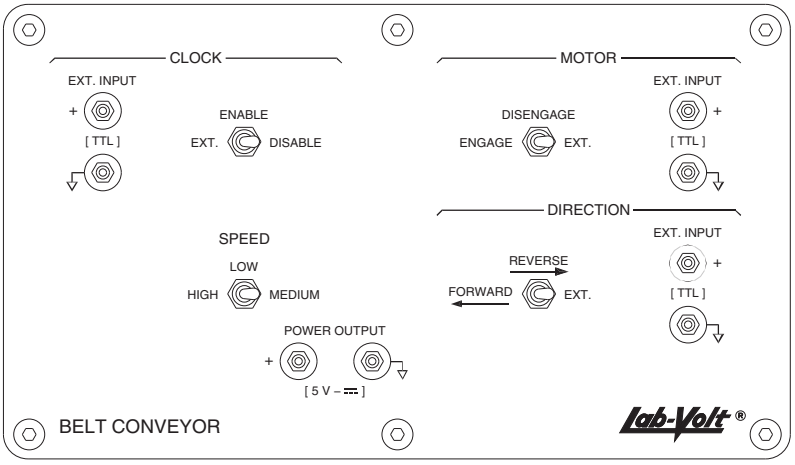

Figure 6-2. Control panel of the Belt Conveyor.

The CLOCK signal is used to stop momentarily the conveyor during the execution of a program. The MOTOR switch is used to start and stop the conveyor belt at the beginning and end of a process.

The DIRECTION switch is used to set the direction of the conveyor belt at REVERSE or FORWARD.

The SPEED switch is used to set the speed of the conveyor belt at LOW, MEDIUM, or HIGH.

External Control

The motor power (MOTOR), motor clock signal (CLOCK), and belt direction (DIRECTION) can also be controlled externally.

To do so, the control switch of the parameter(s) must be set at EXT. The parameter operating mode is determined by setting the TTL level of the corresponding input at high (5 V) or low (0 V) using the TTL outputs.

Industrial Application Simulation Using a Belt Conveyor

The operating mode of the parameters that can be externally controlled versus the TTL level of the EXT. inputs is shown in Table 6-1. As an example, when the TTL level of the MOTOR EXT. input is high, the motor is disengaged.

Controlled Parameter	TTL Level of the Parameter EXT. input	
	Low	High
Motor	Engaged	Disengaged
Clock	Disabled	Enabled
Direction	Forward	Reverse

Table 6-1. Operating modes versus the TTL level of the EXT. inputs.

Limit Switch

The Belt Conveyor is provided with a limit switch. The limit switch is used to detect the presence of objects on the belt. The limit switch is movable, there are several sets of mounting positions found along both sides of the conveyor chassis.

Procedure Summary

In the first part of the exercise, *Set-up*, you will install and connect the Robot Training System and the Belt Conveyor.

In the second part of the exercise, *Direct Control of the Belt Conveyor*, you will operate the conveyor using the switches on the control panel.

In the third part of the exercise, *External Control of the Belt Conveyor*, you will experiment with the external control of the Belt Conveyor. You will create a program that controls the operation and movement direction of the conveyor belt.

In the fourth part of the exercise, *Additional Experiment 1*, you will create a program where a film canister moves on the Belt Conveyor. The movement direction of the belt changes when the limit switch detects the object.

In the fifth part of the exercise, *Additional Experiment 2*, you will create a program where a film canister moves on the Belt Conveyor. The conveyor stops when the limit switch detects the presence of the object. Then the Articulated-Arm Robot picks and returns the film canister to the other extremity of the conveyor.

In the last part of the exercise, *Shutdown procedure*, you will shut down the system.

Industrial Application Simulation Using a Belt Conveyor

EQUIPMENT REQUIRED

Refer to the Equipment Utilization Chart, in Appendix A of this manual, to obtain the list of equipment required to perform this exercise.

PROCEDURE

CAUTION!

When you work with moving equipment, make sure you are not wearing anything that might get caught, such as a tie or jewelry. If your hair is long, tie it out of the way. Avoid touching the stepper motors. They get hot.

Set-up

☐ 1. Install the Articulated-Arm Robot and the Belt Conveyor as shown on the Grid.

Note: *Make sure the limit switch is positioned as shown in Figure 6-3. Move the limit switch if the position differs.*

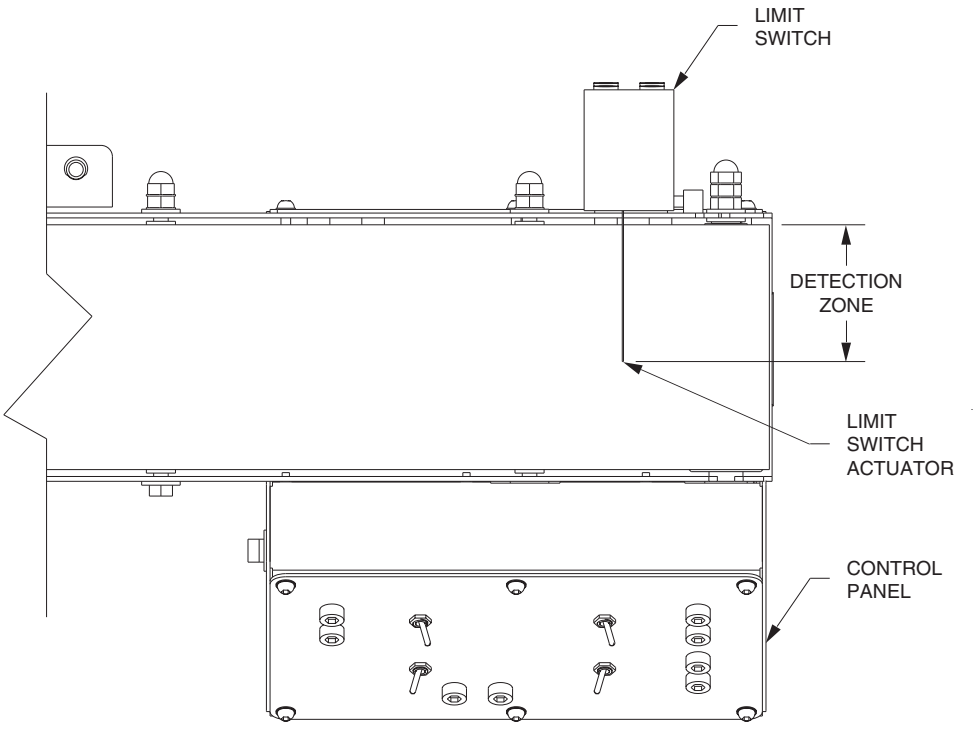

Figure 6-3. Location of the limit switch on the Belt Conveyor.

☐ 2. Connect the equipment as shown in Appendix B. For detailed instructions, refer to the User Guide of your training system.

Connect the Belt Conveyor to an AC power source.

Direct Control of the Belt Conveyor

☐ 3. On the control panel of the Belt Conveyor, set the controls as follows:

CLOCK . . . . . ENABLE
SPEED . . . . . LOW
MOTOR . . . . . DISENGAGE
DIRECTION . . . . . REVERSE

Turn the power on using the switch located on the left side of the control panel.

☐ 4. Set the MOTOR switch at ENGAGE to start the motor.

Familiarize yourself with the operation of the Belt Conveyor by using the CLOCK, MOTOR, SPEED and DIRECTION controls.

Place a film canister on the conveyor and observe its movement while operating each control.

Once your experiment completed, set the MOTOR switch at EXT.

External Control of the Belt Conveyor

☐ 5. Ensure the Power Supply is off.

Note: *Suggested name for this program: EXE_6_A.*

☐ 6. On the control panel of the Belt Conveyor, set the controls as follows:

CLOCK . . . . . DISABLE
SPEED . . . . . MEDIUM
MOTOR . . . . . EXT.
DIRECTION . . . . . REVERSE

☐ 7. Connect the positive terminal of the MOTOR EXT. input on the control panel of Belt Conveyor to TTL output 1 on the base of the Articulated-Arm Robot.

Connect the common terminal of the MOTOR EXT. input to the common terminal of TTL output 1.

☐ 8. On the Belt Conveyor, connect the normally closed (NC) terminal of the limit switch to TTL input 1.

Connect the common terminal of the limit switch to the common terminal of TTL input 1.

☐ 9. Turn the Power Supply on.

☐ 10. Create a program where the Belt Conveyor starts to run when the CLOCK switch is enabled manually and stops when the limit switch detects an object (film canister).

The normally closed (NC) contact of the limit switch controls the TTL level of TTL input 1.

TTL output 1 controls the TTL level of the MOTOR EXT. input of the Belt Conveyor.

Note: *Refer to Table 6-1 to determine the operating mode of the Belt Conveyor versus the TTL level of the EXT. inputs.*

☐ 11. Place manually a film canister on the Belt Conveyor at 30 cm (12 in) approximately from the limit switch. Make sure that the film canister is in the detection zone of the limit switch.

☐ 12. Start your program, then set the CLOCK switch at ENABLE.

Note: *The conveyor belt should move in the reverse direction and stop when the limit switch is actuated by the film canister.*

☐ 13. Once your program is completed, tested, and debugged, save it.

Additional Experiment 1

Note: *Suggested name for this program: EXE_6_B.*

☐ 14. Connect the positive terminal of the DIRECTION EXT. input on the control panel of the Belt Conveyor to TTL output 2 on the base of the Articulated-Arm Robot.

Connect the common terminal of the DIRECTION EXT. input to the common terminal of TTL output 2.

☐ 15. Connect the normally open (NO) terminal of the limit switch to TTL input 2.

Connect the common terminal of the limit switch to the common terminal of TTL input 2.

☐ 16. On the control panel of the Belt Conveyor, set the controls as follows:

CLOCK . . . . . DISABLE
SPEED . . . . . MEDIUM
MOTOR . . . . . .ENGAGE
DIRECTION . . . . . EXT.

☐ 17. Create a program where the Belt Conveyor starts to run in the reverse direction when the CLOCK switch is enabled manually and changes direction when the limit switch detects an object (film canister).

TTL output 2 controls the TTL level of the DIRECTION EXT. input of the Belt Conveyor.

Note: *Refer to Table 6-1 to determine the operating mode of the Belt Conveyor versus the TTL level of the EXT. inputs.*

☐ 18. Place a film canister on the Belt Conveyor at 30 cm (12 in) approximately from the limit switch. Make sure that the film canister is in the detection zone of the limit switch.

☐ 19. Start your program, then set the CLOCK switch at ENABLE.

Note: *The belt of the conveyor will move in the reverse direction, and will change direction when the limit switch is actuated by the film canister.*

☐ 20. Stop the program by setting the CLOCK switch at DISABLE before the film canister falls down at the extremity of the belt.

☐ 21. Once your program is completed, tested, and debugged, save it.

Additional Experiment 2

Note: *Suggested name for this program: EXE_6_C.*

☐ 22. Create a program where a film canister moves on the Belt Conveyor from position A to position B at medium speed (refer to Figure 6-4). The conveyor stops when the limit switch detects the presence of the film canister at position B.

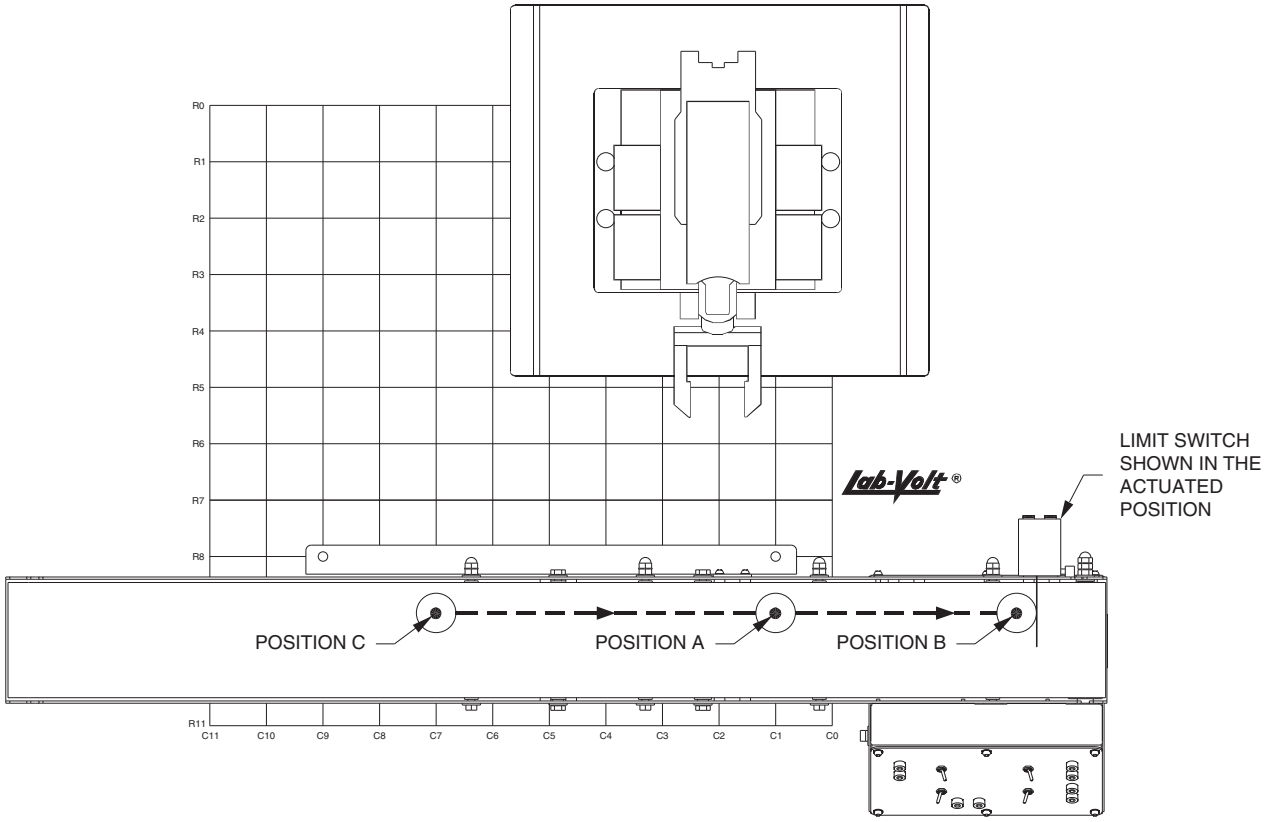

Figure 6-4. Location of the equipment on the Grid.

Then the Articulated-Arm Robot picks up the film canister and moves it at position C on the Belt Conveyor. The program repeats automatically.

Use the external CLOCK function to stop the conveyor momentarily when the film canister is detected by the limit switch and moved by the Articulated-Arm Robot.

> **Note:** *Refer to Table 6-1 to determine the operating mode of the Belt Conveyor versus the TTL level of the EXT. inputs.*

Do not forget to perform a home positioning at the beginning of your program.

> **Note:** *When positioning the film canister with the Articulated-Arm Robot at position C, place the film canister at the same distance from the border of the belt as it was originally placed at the beginning of the program (at position A).*

☐ 23. Once your program is completed, tested, and debugged, save it.

Shutdown Procedure

☐ 24. Turn the Power Supply off.

☐ 25. Disconnect the system and return the equipment to its storage location.

CONCLUSION

In this exercise you were introduced to the Belt Conveyor operation. You learned how to control the conveyor directly and externally. You also learned how to use the output signal of the limit switch to trigger a control instruction in a program.

REVIEW QUESTIONS

1. What is the limit switch used for on the Belt Conveyor?

_____

_____

_____

2. Name four types of part feeders.

_____

_____

3. Name three parameters that can be externally controlled on the Belt Conveyor.

_____

_____

_____

4. Which parameter is used to momentarily stop the conveyor belt during a program?

_____

_____

_____

5. Which parameter is used to stop the conveyor belt at the end of a program?

Instructor Guide Sample

Extracted from

Introduction to Robotics

EXERCISE 6 INDUSTRIAL APPLICATION SIMULATION USING A BELT CONVEYOR

ANSWERS TO REVIEW QUESTIONS

1. To detect the presence of objects on the belt.

2. Gravity, pneumatic, rotary carousel, and belt conveyor.

3. Motor power (MOTOR), motor clock signal (CLOCK), and belt direction (DIRECTION).

4. Motor clock signal (CLOCK).

5. Motor power (MOTOR).