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INSTITUTE OF APPLIED TECHNOLOGY

PLC

Module 5:
Control Applications

PREPARED BY

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Control Applications

Module Objectives

Upon successful completion of this module, students should be able to:

1. Demonstrate understanding of simple PLC control applications.
2. Identify the major control elements of the application.
3. Give an example of a PLC Control application, state the inputs and outputs and define the control elements.
4. Develop and implement a simple PLC control application.

Module Contents:

5.1 Introduction

Mechatronics application can be implemented in the traditional methods by using Electrical circuits and wiring. Although these solutions have been in use for a long time and are still in use, the PLC solutions are replacing these old systems as they reduce the wiring hassles and provide high flexibility in modifyng control process.

With LOGO! PLC we can implement a lot of applications which require the use of different functions of the PLC.

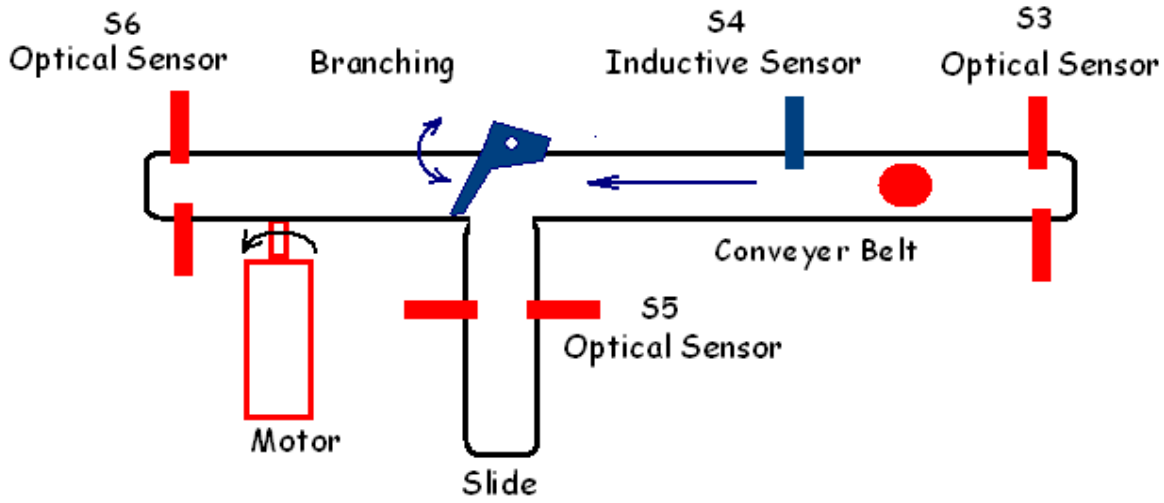
In this module we have provided three applications to give students an overview of the versatile use of LOGO!.

5.2 Application 1 : Conveyer Belt

The conveyer belt is widely used in industry and in automatic control applications in which a PLC could be used to implement the desired task.

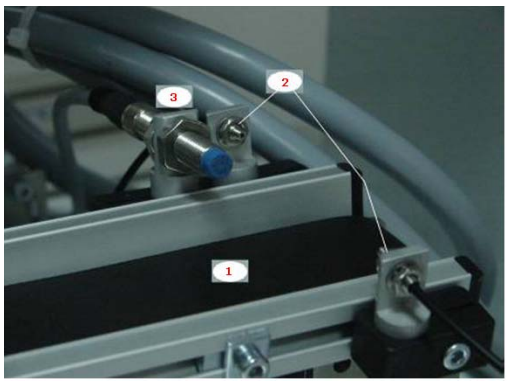
In this application, the system will convey and detect the presence of the work piece and it will also sort out the silver metallic work pieces.

The conveyer belt parts are as follows



The conveyer belt and sensors locations

Conveyer belt machine parts:

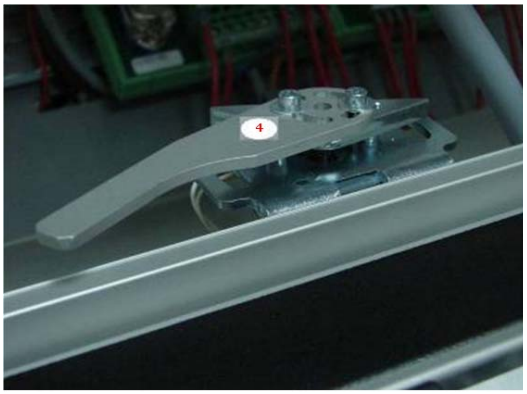


1- Conveyor Belt:
This is the transportation media on which the work pieces are transported.

2- Fiber optic Sensor:
This sensor is used to detect the presence of a work piece regardless of its color and material.

3- Inductive Sensor:
This sensor is used to detect metal parts, and its detection distance is up to 4 mm.

4- Branching Module:
This is a motorized assembly by which branching of a work piece is done.



5- Fiber optic Sensor:
This sensor is used to detect the passing of a work piece regardless of its color and material.

6- Fiber optic diffuse type sensor:
It emits visible red light, objects are detected when they reflect the light.

7- DC Motor
It moves the conveyor belt with the aid of the gearbox.

8- Gear Box
It is used to decrease the speed and to increase the torque.

9- Work pieces:
There are three types of work pieces, black and red work pieces which are plastic and Silver work pieces which are made from aluminum.

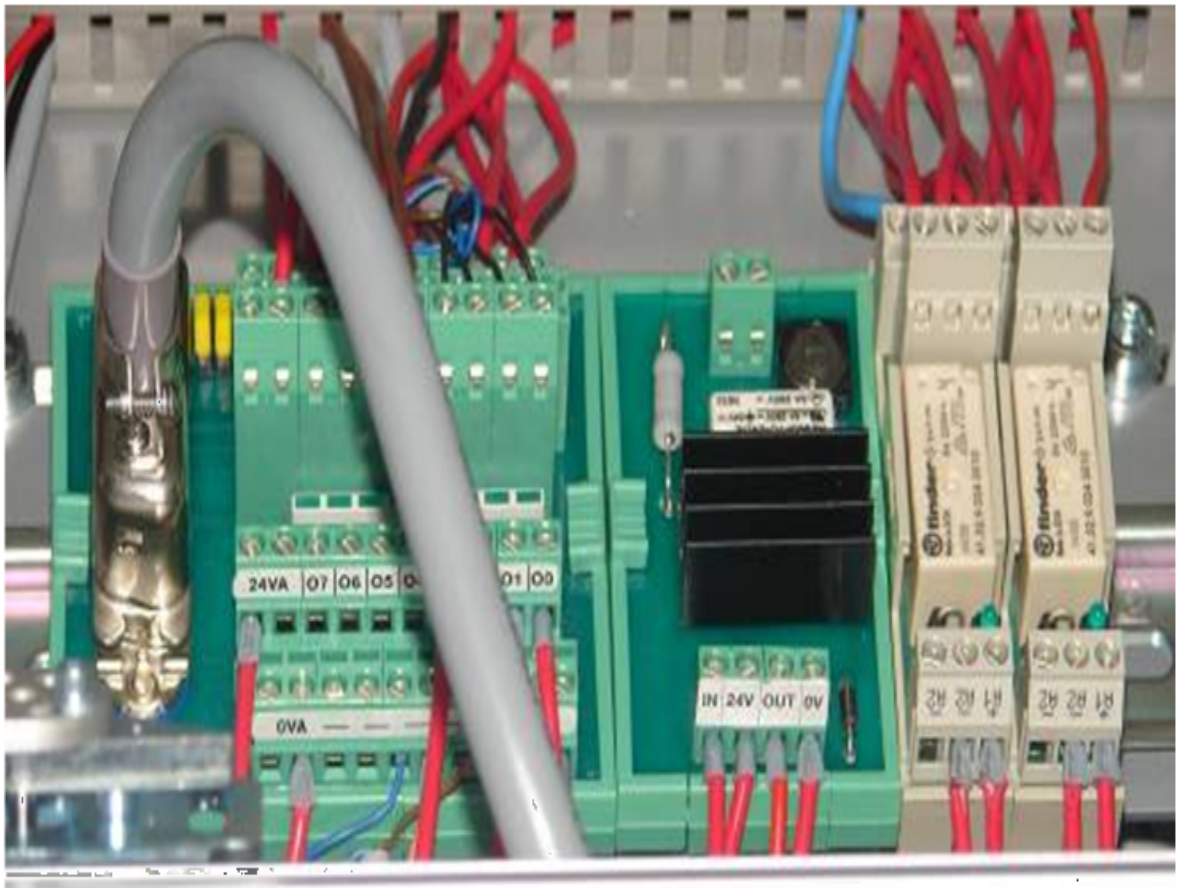

Red Plastic
Work piece


Black Plastic
Work piece


Silver Metallic
Work piece

10- Interfacing Unit:

This unit interfaces the LOGO! PLC with the EduTrainer's sensors and actuators. It gets the controlling signals from the PLC via the System Link cable mentioned before. It has an LED for each input and output to visualize the signals and to make the troubleshooting phase easier.



Interfacing Unit

The interface unit and the PLC both have different numbering for their inputs/output ports which requires the programmer to refer to the table below when programming the with the machine.

The following allocation lists show the complete connections in the EduTrainer.

Inputs	PLC side	Interfacing Unit side
Green push button (N.O.)	I1	---
Red push button (N.C.)	I2	---
White push button (N.O.)	I3	---
Selector Switch	I4	---
Emergency Jumper	I5	---
Sensor number (8)	I9	I0
Sensor number (14)	I10	I1
Sensor number (17)	I11	I2
Sensor number (9)	I12	I3
Sensor number (20-a)	I13	I4
Sensor number (20-b)	I14	I5

Outputs	PLC side	Interfacing Unit side
Green Light	Q1	---
White Light	Q2	---
Table Forward	Q5	Q0
Table Backward	Q6	Q1
Branching Arm	Q7	Q2
Conveyor belt Motor	Q8	Q3

PLC inputs and outputs versus interface unit inputs and outputs

5.3 Lab Activity 1

Objective:

To demonstrate understanding of simple PLC control applications.

Control Requirements:

The requirement for the control is to program the machine to do the following,

1- When the green push button is pressed, the belt start moving **OR**
2- When a work piece is on the belt (detected by S3), the belt will also start moving.
3- If the piece is metal (detected by S4), the branching arm will extend.
4- The branching arm will move backward when the piece slides down (detected by S5).
5- The conveyer belt stops when the piece slides down (detected by S5) **or** when the piece reaches the end of the belt (detected by S6).
6- Stop push button will also stop the belt.

Procedure:

Step 1:
Identify the inputs and the outputs for the conveyer belt machine and assign the PLC inputs and outputs.

The inputs:

Sr.	Input	Abbreviation	PLC Side input	Interface Side input
1	Start (ON) Push button	S1	I1	---
2	Stop (OFF) Push button	S2	I2	---
3	Fiber optic Sensor	S3	I9	I0
4	Inductive Sensor	S4	I10	I1
5	Fiber optic Sensor	S5	I11	I2
6	Fiber optic diffuse type sensor	S6	I12	I3

The outputs:

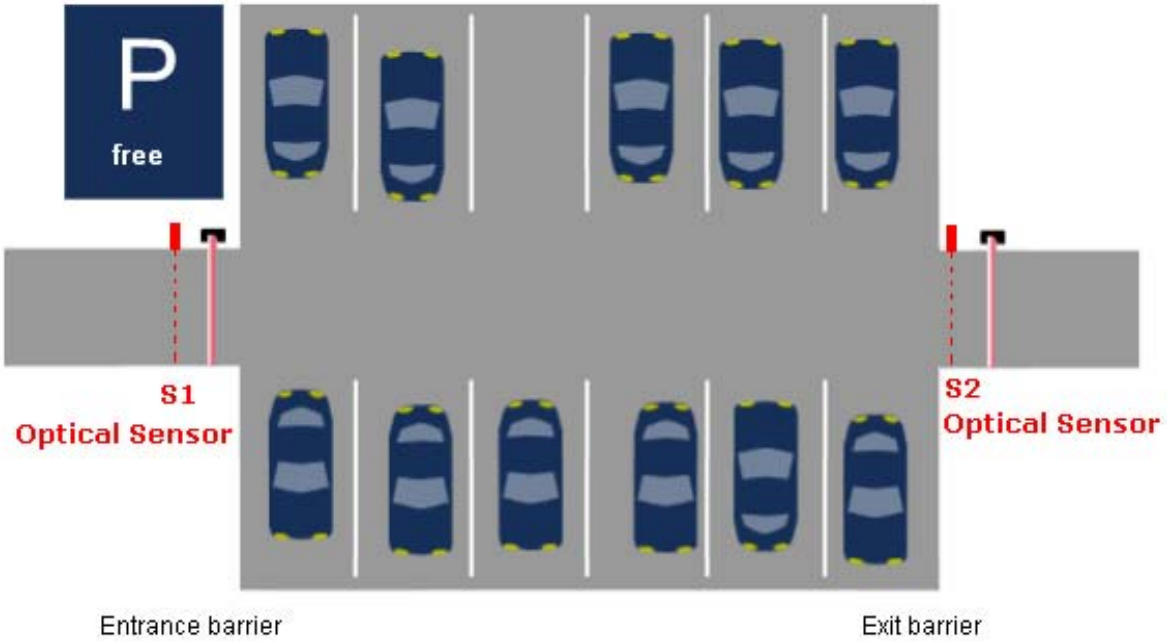
Sr.	Output	Abbreviation	PLC Side output	Interface Side output
1	DC Motor	M1	Q8	Q0
2	Branching Module	M2	Q7	Q1

Step 2:

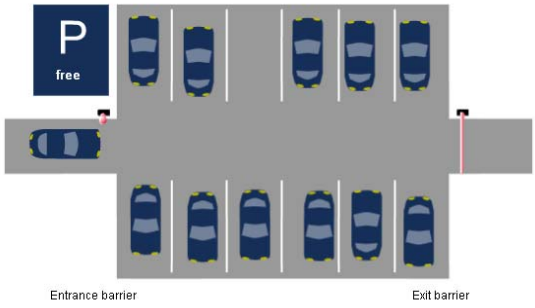
Draw a ladder program to meet the desired operation

5.4 Application 2 : Car-Park Entrance Control System

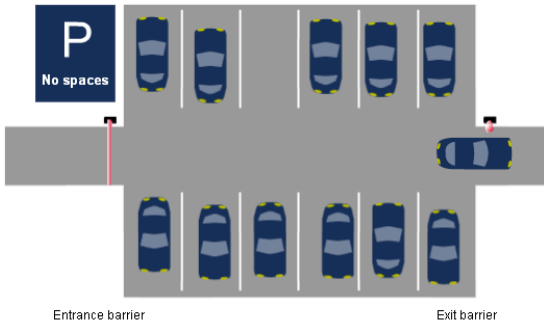
Entrance control system in multi-storey car park.



The first sensor S1 at the entrance, senses a car entering the car park, and the entrance barrier opens the gate.



The second sensor S2 senses a car leaving the car park, and the barrier opens the exit gate.



A counter keeps track of the number of cars in the car park whereby “free spaces” and “no spaces” sign is controlled.

Sign 2: Parking Free

Sign 1: No Spaces

5.5 Lab Activity 2

Objective:

By the end of this application, the students should be able to demonstrate understanding of PLC timers and counters in control applications.

Control Requirements:

The required control is to program the PLC to do the following,

1- If there is a car at the entrance gate (detected by S1), the barrier 1 opens for 5 seconds then closes automatically.

2- If there is a car that wants to exit the parking (detected by S2), the barrier 2 opens for 5 seconds then closes automatically.

3- If the number of cars in the parking lot is less than 12, the sign of “Parking Free” lights up.

3- If the number of cars in the parking lot is equal to or greater than 12, the sign of “No Spaces” lights up.

Procedure:

Step 1:

Define the inputs and the outputs for the Car park system and assign the PLC inputs and outputs.

The Inputs:

Sr.	Input	Abbreviation	PLC Side input	Interface Side input
1	Entrance optical Sensor	S1	I10	
2	Exit optical Sensor	S2	I11	

The Outputs:

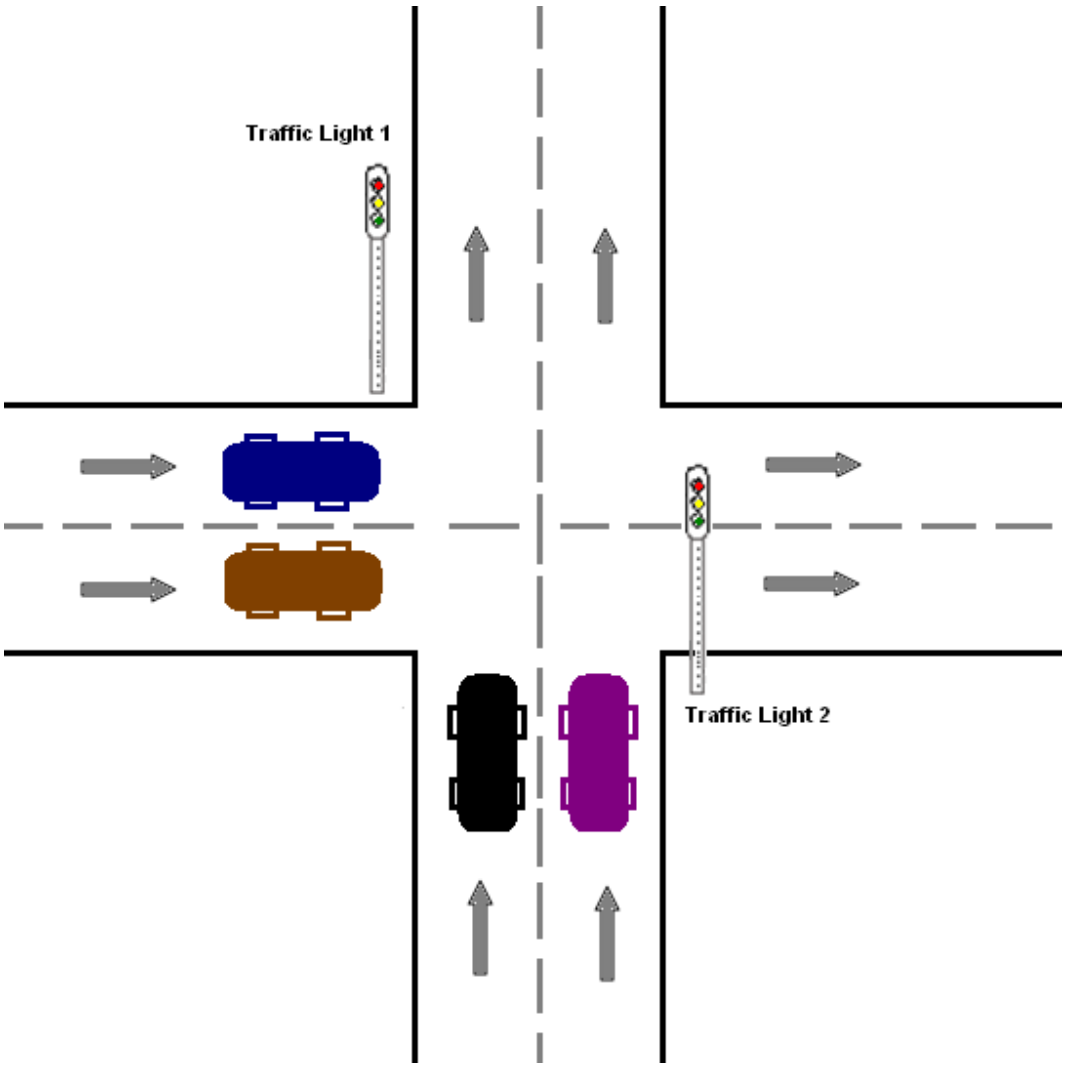
Sr.	Input	Abbreviation	PLC Side output	Interface Side input
1	Entrance gate motor	M1	Q5	
2	Exit gate motor	M2	Q6	
3	Light1 “Parking Free”	L1	Q7	
4	Light2 “No Spaces”	L2	Q8	

Step 2:

Draw a ladder program to meet the desired operation

5.6 Application 3 : Traffic Light System

Consider a traffic signal used at an intersection. The normal sequence for traffic lights are green light at one side of intersection, for a long time, usually 10 or more seconds. Then followed by a brief yellow light, typically for 4 seconds and then the red light to stop any traffic. The other traffic signal follows a similar pattern of lights in the opposite direction. It is clear that the green light or yellow light in one direction implies a red light in the opposite direction.



The first step in the development of the controller is to define the inputs and outputs of the system; then define the system state in process then

writing and testing the program.

5.7 Lab Activity 3

Objective:

By the end of this application, the students should be able to use sequence control and the PLC timers in control applications.

Control Requirements :
The required control is to program the PLC to do the following,

1- Signal 1 will work in sequence Red, Green then yellow.
2- Signal 2 will work in sequence Red, Green then yellow.
3- The Green light will work for 5 seconds.
4- The yellow light will work for 1 second.

Procedure:

Step 1:
Define the inputs and the outputs for Traffic Light and assign the PLC inputs and outputs.

The inputs:

Sr.	Input	Abbreviation	PLC Side input	Interface Side input
1	Push button ON	S1	I1	

The outputs:

Sr.	Input	Abbreviation	PLC Side input	Interface Side input
1	Traffic Light 1 Red Lamp (L1)	L1	Q5	
2	Yellow Lamp (L2)	L2	Q6	
3	Green Lamp (L3)	L3	Q7	
4	Traffic Light 2 Red Lamp (L4)	L4	Q8	

5	Yellow Lamp (L5)	L5	Q9	
6	Green Lamp (L6)	L6	Q10	

Step 2:

Define the system state in process.
Here are the light sequences listed in order.

Description	Signal 1			Signal 2		
	Red L1	Yellow L2	Green L3	Red L4	Yellow L5	Green L6
Signal 2 Green	1					1
Signal 2 Yellow	1				1	
Signal 1 Green			1	1		
Signal 1 Yellow		1		1		

Step3:

Draw a ladder program to meet the desired operation

5.8 Module exercise

1. What is the difference between inductive sensor and fiber optic sensor?

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2. Write the function for each one of the following conveyer belt machine parts

No.	Part	Function
1	Conveyor Belt	
2	Branching Module	
3	Fiber optic diffuse type sensor	
4	Gear Box	

3. Explain why the first input in the interface unit is I9 and the first output is Q5?

(Hint: interface unit is connected to the expansion units)

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4. Which sensor is the best for the entrance of car parks?

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5. For the following parking system draw the ladder diagram and function block diagram.

   - Car entrance barrier (Q1) will open if the sensor connected to (I1) detects the presence of a car.
   - Car exit barrier (Q2) will open if the sensor connected to (I2) detects the presence of a car.
   - If the number of cars inside the parking is 20 the entrance barrier will not open and a sign board (Q3) will show NO Parking available.

Ladder Diagram	
Function Block Diagram	

6. Draw the ladder diagram for the pedestrian traffic signal.

The signal will allow pedestrians and road traffic to use the crossing alternately.

- Normally when there are no pedestrians, cars are allowed to use the crossing (move)
- Once a pedestrian decides to cross the road , a push button must be pressed.
- A time delay will give a chance for some cars to move and the car's signal changes from green to yellow, and then to red
- Then the pedestrian signal changes from red to green and stays green for a certain time just to let pedestrians cross the road safely
- Finally the pedestrian signal changes to red and cars signal changes to green.

Q1	Red for cars
Q2	Yellow for cars
Q3	Green for cars
Q4	Red for pedestrian
Q5	Green for pedestrian
I1	Push button

7. **Interlocking** is defined as an "arrangement of signals and switches such that they are constrained to be operable only in a safe order or in simple words, Interlocking is a method of preventing undesired states in a machine.

   For example, in a vending machine when you insert a coin and order 2 items you get only one of them.

   A motor rotates in forward direction (Q1) when push button (I1) is pressed. The same motor rotates in the backward direction (Q2) when push button (I2) is pressed. The third push button which is (I3) is used to switch off the motor.

   Use the interlock idea to draw the ladder diagram for the above requirements.

   Note (if the motor is in the forward direction you must not be able to switch it directly into the backward direction)