PROGRAMMABLE LOGIC CONTROLLERS

Laboratory Experiments

(These laboratory experiments are based on Allen-Bradley PLC Series 5 instruction set)

Akram Hossain

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# Table of Contents

<table>
<thead>
<tr>
<th>Laboratory</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to PLC Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Start/Stop Motor Control</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Sequential Motor Starter</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>Parking Lot Controller Using Counter Instruction</td>
<td>19</td>
</tr>
<tr>
<td>5</td>
<td>Parking Lot Controller Using Arithmetic and Logical Instruction</td>
<td>33</td>
</tr>
<tr>
<td>6</td>
<td>Start-Forward-Stop-Reverse Control</td>
<td>39</td>
</tr>
<tr>
<td>7</td>
<td>Forward and Reverse Control</td>
<td>44</td>
</tr>
<tr>
<td>8</td>
<td>Star to Delta 3-Phase Motor Starter</td>
<td>58</td>
</tr>
<tr>
<td>9</td>
<td>Faulty Occurrence Timer</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>An Industrial Process Control System</td>
<td>71</td>
</tr>
<tr>
<td>11</td>
<td>An Industrial Process Control System with Advanced Features</td>
<td>76</td>
</tr>
<tr>
<td>12</td>
<td>Block Transfer Read and Write for Analog Data</td>
<td>80</td>
</tr>
<tr>
<td>13</td>
<td>Analog Input/Out Communication Using A-B PLC-5 for Industrial Control Application</td>
<td>84</td>
</tr>
</tbody>
</table>
INTRODUCTION
There is no doubt that the art of automatic control dominates the way of life in modern America, and must be considered as one of the most necessary ingredient of education in this country. One of the key tools that are used to do the modern process control is programmable logic controllers (PLCs). They are considered as a key tool to control the logical steps of an industrial process. PLCs have acquired outstanding reputation for themselves in the field of industrial process control. Because of our strategic location in northwest Indiana, where in addition to many other industries many major steel companies are located within ten miles from Purdue University Calumet, automatic control using PLCs is the way of life in this region. For the last couple of years these steel industries and other industries have spent lots of money for the modernization of their process control equipment to compete with their foreign competitor. Among many things the one that salvaged the existing process equipment is PLCs. PLCs have successfully replaced discrete electronics and electromagnetic control systems. This massive modernization causes a short fall of properly trained personnel in the area of programmable logic controllers and their applications. ECET graduates with adequate knowledge and background in the area of PLCs, and Instrumentation will create positive impact on the growth of the local industry. The area of Electrical and Computer Engineering Technology has responded to this present need of the industry and likes to provide graduates with hands-on background in modern PLCs, industrial process control, and Instrumentation.

This Programmable Logic Controllers (PLCs) course is especially designed to provide both theoretical and hands-on experiences on PLCs. This one semester comprehensive course, couple with laboratory experiments, was designed to provide students and practicing engineers with the knowledge and confidence they might need to understand the fundamentals, working principles, architecture, programming, and applications of PLCs. There is no doubt that pursuing this course and laboratory work on PLCs and their applications would be a worthwhile experience for all.

Undoubtedly PLCs are valuable aspect of the technology. Therefore, the department is offering this PLC course to students

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ELECTRICAL SAFETY IN LABORATORY

Students are required to work with 120V and 250V AC and DC power supply system in PLC laboratory. Voltage above 50V is considered to be lethal (deadly). Students need to be aware of the hazard involved in working with such voltage level. Therefore, I ask the student to take extreme precaution while working with PLCs. I recommend the following as a general practice while working in the laboratory.

[1] SAFETY FIRST. Abide by the safety rules is every student’s responsibility.
[2] Read both the Electrical Precautionary notes provided with this Manual.
[3] Always work under the supervision of laboratory instructor while working in the laboratory.
[4] Always work with one other person while working with lethal voltages.
[5] Before you switch-ON (power up or apply power to an experimental setup) your instructor must check the circuit in addition to you verifying the experimental setup to see all safety conditions are satisfactory meaning if you turn the circuit ON no one (including you) will be electrocuted, get electric shock or get hurt by any other means. Remember rotating machinery is also one of the hazards in laboratory experimental setups.
[6] If you have any doubts regarding your circuit wiring and safety of yourself or others, please do not switch ON (do not power up the circuit) and immediately contact your laboratory instructor or course instructor regarding safety condition.
[7] Never leave the laboratory without disconnecting the experimental setup for the power source. If a student or a group of students have to keep an experimental setup connected overnight or for several days, it is responsibility of the student or the students group to disconnect the setup from power source, must leave written note with a phone number, and keep the set up in a manner that it is difficult for others (someone unauthorized) to power up the experimental setup.

ADDITIONAL NOTES ON SAFETY

General Discussion on Safety on the First Day of the Laboratory:
Safety is everyone’s responsibility. From the head of the school down to the student everyone should remain responsible for their action. However, discussions, questions and answers on safety issues will help the students to build up their awareness and in turn will reduce the chances of laboratory accidents.

Moving Machinery:
The moving machinery, such as drill press board cutter, the lathe, are also a potential source of danger. Eye protection must always be worn when operating these types of machinery. A good practice to work with these machinery involves two students. When one of the students will use the machine to perform the desired work, the other student stands by the OFF switch. In this way, the standby student can turn the machinery OFF if the operator has a problem. The wearing of loose clothing, such as necktie, long sleeves, etc. or jewelry should be avoided. These items of wear can provide a situation where they can get caught in the moving machinery. In the event something of this nature happens, there is second student to switch the machine OFF. When using the drill press, remember to clamp the piece being drilled. This prevents the drill from catching the working piece and causing a situation where the hand or arm could be cut.
GRAYMARK CARES ABOUT YOUR SAFETY

Understanding the Electrical Resistance of Your Body

Current is forced through the resistance of a circuit by voltage, which is electrical pressure or force. A lower resistance in the circuit allows more current to pass through the circuit for a given amount of voltage.

If you think of the human body as a circuit, then the amount of current that can flow between any two points of the body depends on the resistance between those two points at that time and the amount of voltage or electrical pressure applied. Normally, your skin resistance is high. This high resistance tends to impede the current flowing into and out of your body. However, there are several conditions which can lower skin resistance drastically and which permit a larger amount of current to pass through your body with the same voltage applied.

The average body resistance is over 100,000 ohms. However, if your skin is wet from perspiration or other moisture, or if your pulse rate is high, your body’s resistance can be as low as a few hundred ohms.

Also, if your skin is broken with a cut or an abrasion, a lesser voltage is required at that point to force the same amount of current through your body.

Precautions to be Used When Working with Electronic Circuits

1. Practice a precaution used by experienced technicians. Try to keep one hand in your pocket or behind you, when you are making voltage and current measurements. If two hands are in contact with the circuit or if one hand is in contact with the circuit and the other hand is in contact with ground (such as a metal panel or the case of a piece of test equipment), the current path is across the chest where the heart, and lungs are located. This is extremely dangerous.

2. Do not work on electronic circuits when the power is on, except when absolutely necessary.

3. Electrolytic and other large capacitors can hold a voltage charge for several hours after the power is removed. Make it a habit to check if they are fully discharged by shorting them with a screwdriver with an insulated handle or clip lead before working on a circuit.

4. Do not work on electronic equipment while standing on a damp floor or when leaning on any metal object.

5. Certain components, such as resistors and vacuum tubes, get quite hot. Give them time to cool off before removing them.

6. Make it a point to know the location of an available fire extinguisher and how to use it.

7. Be sure equipment is in proper working order before you use it. Frayed, cracked, or burnt power cords and cracked or chipped plugs are a major source of accidents.

Safety Is Everyone’s Responsibility. Where your personal life and good health are concerned, safety becomes your responsibility. Whether you lie in the path of a car or expose yourself to a lethal electrical shock are matters over which you, as an individual, have more control than anyone else.

Familiarize yourself with these safety precautions before working with any electronic circuits, and your experience will be pleasant and rewarding.

We care about your personal safety as much as we care about your learning electronics.
How Much Current Is Fatal?

THE FOLLOWING information, supplied by Tektronics Inc., is something we feel should be read and understood by all electronics experimenters, technicians, hams, and engineers, regardless of what area of electronics or electrical work they are in.

Unfortunately, most of us think that a shock of 10 kV would be more deadly than one of 100 volts. This is not so. People have been electrocuted by ordinary 117-volt appliances and by voltages as low as 42 volts dc! The real measure of the degree of shock is not the voltage applied, but the amount of current forced through the body—and that need not be very much.

While any amount of current over 10 mA is capable of producing a painful to a severe shock (as shown in the chart), current between 100 and 200 mA can be considered lethal. Currents above 200 mA, while producing severe burns and unconsciousness, do not usually cause death if the victim is given immediate resuscitation (artificial respiration).

Voltage is not a consideration; it is important only because its level and the body resistance between the points of contact determine how much current flows. Since resistance varies greatly, it is impossible to predict a dangerous voltage. The resistance may vary from 1000 ohms for wet skin to over 500,000 ohms for dry skin—remembering that the resistance from point to point under the skin may be only a few hundred ohms. Also remember that the contact resistance decreases with time and the fatal current may be reached rapidly.

As shown on the chart, a current as low as 20 mA is very dangerous and painful, and the victim can't let go of the circuit. As the current approaches 100 mA, ventricular fibrillation of the heart usually occurs. Above 200 mA, the muscular contractions are so severe that the heart is often forcibly clamped during the shock. This clamping sometimes prevents the heart from going into ventricular fibrillation and the victim's chances for survival are good.

Now, what lesson can we learn from all of this? First, regard all voltage sources (even some batteries) as potential killers.

When working around electrical equipment make sure you know where you are with respect to the voltage source. Don't lounge after fallen tools. Kill all power before diving into circuits. Don't work when you are mentally or physically fatigued. Keep one hand in your pocket when investigating live electrical equipment. Be particularly observant of what you are standing on—don't work on a metal floor, damp concrete, or any other well-grounded surface. Don't handle electrical equipment while wearing damp clothing—particularly shoes—or when the skin is wet from water or perspiration.

In the event of an accident, either cut the voltage or get the victim away from his contact—using some form of insulation to do the job or you will get caught too. If the victim is unconscious and has stopped breathing, start artificial respiration at once. Do not stop until proper medical aid has arrived.
INTRODUCTION TO PROGRAMMABLE LOGIC CONTROLLER LABORATORY EQUIPMENT AND SETUPS

OBJECTIVE
To make students familiar with the following laboratory resources:

1. Power sources: 208V 3φ AC, 120V 3φ AC, 120 VDC (variable)
2. Allen-Bradley PLC Series 5 stations (Eight)
3. Wiring schedule of PLC stations
4. Process module and architecture
5. Input and output module wiring
6. Safety issues and laboratory rules
<title>PLC Station Wiring 120 VAC Input & Output Module</title>

**Processor Module**
- COMM
- BATT
- PROC
- FORCE
- REM
- RUN

**Power Supply**
- DATA HIGHWAY PLUS
- 1778-KF2
- 25 PIN DB (RS 232C)
- 9 PIN DB (RS 232C)

**120 V AC Input Module**
- Terminal connections:
  - Terminals 00-16 and Neutral
  - NC, NC, NC, NC, NC, NC, NC, NC, NC, NC, NC, NC, NC, NC, NC, NC

**120 V AC Output Module**
- Terminal connections:
  - Terminals 00-16 and Neutral
  - L1, L1, L1, L1, L1, L1, L1, L1, L1, L1, L1, L1, L1, L1, L1, L1

**Other Connections**
- DB 9 or 8 PIN DIN
- Process
- COMM
- BATT
- PROC
- FORCE
- REM
- RUN

**Data Highway Plus 1778-KF2**
- 25 PIN DB (RS 232C)
- 9 PIN DB (RS 232C)

**Color Codes**
- AWG 18 in Red or other Color, except Green, Black, and White
- Alternate color codes

**Relay**
- Start SW
- Stop SW

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PLC Station Wiring Schedule for Analog Input & Output Module

Drawn By: Akram Hossain, Professor of ECET

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**TTL INPUT MODULE**

- Input 00-17 AWG 18 in other Color except Red and Green
- Input 00
- Input 01
- Input 02
- Input 03
- Input 04
- Input 05
- Input 06
- Input 07
- Input 08
- Input 09
- Input 10
- Input 11
- Input 12
- Input 13
- Input 14
- Input 15
- Input 16
- Input 17

**TTL OUTPUT MODULE**

- Output 00-07 in AWG 18 in other Color except Red and Green
- Output 00
- Output 01
- Output 02
- Output 03
- Output 04
- Output 05
- Output 06
- Output 07

**Power Supply**

- +5V DC

**Connector Types**

- DB 9 or 8 PIN DIN
- 25 PIN DB (RS 232C)
- 9 PIN DB (RS 232C)

**Other Details**

- Data Highway Plus 1778-KF2
- Processor Module
- BATT
- COMM
- PROC
- FORCE
- RUN
- REM
- PROG

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PLC Station Wiring Schedule for TTL Input & Output Module

Different Types of TTL Input and Output Module

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PLC Station Wiring 120 VAC Input & Output Module

Data Highway Plus 1778-KF2

Power Supply

120 V AC Input Module

120 V AC Output Module

TERMINAL 00-16 and Neutral

NC NC NC NC NC NC

00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17

Green Black Green Black

AWG 18 in Red or other Color, except Green, Black and White. Alternate color codes

NC NC NC NC NC NC

00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17

Green Black Green Black

AWG 18 in Red or other Color, except Green, Black and White. Alternate color codes

NC NC NC NC NC NC

00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17

Green Black Green Black

AWG 18 in Red or other Color, except Green, Black and White. Alternate color codes

NC NC NC NC NC NC

00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17

Green Black Green Black

AWG 18 in Red or other Color, except Green, Black and White. Alternate color codes

NC NC NC NC NC NC

00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17

Green Black Green Black

AWG 18 in Red or other Color, except Green, Black and White. Alternate color codes

NC NC NC NC NC NC

00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17

Green Black Green Black

AWG 18 in Red or other Color, except Green, Black and White. Alternate color codes

Relay

Start SW

Stop SW

PROCESSOR

COMM BATT

PROC FORCE

REM RUN

POWER SUPPLY

Data Highway Plus 1778-KF2

25 PIN DB (RS 232C)

9 PIN DB (RS 232C)

25 PIN DB (RS 232C)

FROM COM 1

25 PIN DB (RS 232C)
START/STOP MOTOR CONTROL

OBJECTIVE

Design and connect a ladder logic control for a simple starter system of a 3 phase AC motor. The starter has one start and one stop switch. Both of the switches are momentary contact switch. Start switch is normally open and stop switch is normally close. Output relay, C1, controls the 3-phase supply to the motor. The motor has a stop and a run indicator lights.

EQUIPMENT AND SUPPLIES

1. PLC Series 5 Station having 120VAC Input and Output Modules
2. Power source:120 V, 3φ, 60 Hz (Panel B)
3. 208 V, 3φ, 60 Hz (Panel A)
4. 3 Phase AC Motor, Momentary contact switches
5. Electromagnetic contactors or solid state relays
6. 250V, 15A rated wires

RELAY CONTROL DIAGRAM

[Diagram of relay control and 3 phase power diagram]
LABORATORY ASSIGNMENTS
1. Design ladder logic diagram using RS Logic 5 ladder editor for Allen-Bradley PLC Series 5.
2. Connect PLC to motor, motor power circuit, and other necessary items for proper operation of the system.
3. Debug and document the result in the form of a report.

FORMAT AND STANDARDS FOR LABORATORY ASSIGNMENTS
1. Laboratory reports and other hand-in assignments are expected to conform to the format and standards described and illustrated below. Use computer word processor for project reports.
2. Must have a title page, which should contain the following information:
   a. Project title or assignment title.
   b. Student's full name (please print)
   c. Course number
   d. Division number
   e. Due date
   f. Actual Date of Assignment Submission
3. Physical layout of the control circuit or process.
4. Description of the problem being solved using PLC.
5. Ladder logic diagram (print out of the ladder diagram).
6. Description of logical operation of the problem using ladder diagram.
SEQUENTIAL MOTOR STARTER

OBJECTIVES

Three DC motors need to be sequentially started automatically with 30 second time delay between each motor. All motors are switched off at one time by one stop switch. Start switch is normally open and momentary contact switch. Output relay M1, M2 and M3 control the supply to the first, second and third motor. The stop switch is normally close and momentary contact. Each motor should have an off and run light to indicate that the motor is running or at rest.

EQUIPMENT AND SUPPLIES

1. PLC Series 5 Station having 120VAC Input and Output Modules
2. Power source: 80/100VDC Source
3. 120V 1Φ, 60 Hz Source
4. Three DC Motor, Momentary contact switches
5. Electromagnetic contactors or solid state relays
6. 250V, 15A rated wires

POWER DIAGRAM FOR ONE OF THE DC MOTORS
LABORATORY ASSIGNMENTS
1. Design ladder logic diagram.
2. Connect PLC to motor, motor power circuit, and other necessary items for proper operation of the system.
3. Debug and document the result in the form of a report.

FORMAT AND STANDARDS FOR LABORATORY ASSIGNMENTS
1. Laboratory reports and other hand-in assignments are expected to conform to the format and standards described and illustrated below. Use computer word processor for project reports.

2. Must have a title page, which should contain the following information:
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   b. Student's full name (please print)
   c. Course number
   d. Division number
   e. Due date
   f. Actual Date of Assignment Submission

3. Physical layout of the control circuit or process.
4. Description of the problem being solved using PLC.
5. Ladder logic diagram (print out of the ladder diagram).
6. Description of logical operation of the problem using ladder diagram.
PARKING LOT CONTROLLER USING COUNTER INSTRUCTION

OBJECTIVE

A parking lot can accommodate 20 cars. A counter system needs to be design using A-B PLC-5. The parking lot has one entry and one exit gate. If a car enters or leaves the parking lot a signal is sent to PLC-5 and thus it will keeps track of the number of cars in the parking lot. If at any time the parking lot is full (car = 20), the system will inhibit cars to enter the parking lot. A parking-lot-full-indicator light will also light-up.

EQUIPMENT AND SUPPLIES

1. PLC Series 5 Station having 120VAC Input and Output Modules
2. 120V 1φ, 60 Hz Source
3. Momentary contact switches
4. 250V, 15A rated wires
5. 120 V Light Blubs

LABORATORY ASSIGNMENTS

1. Design ladder logic diagram.
2. Connect PLC to motor, motor power circuit, and other necessary items for proper operation of the system.
3. Debug and document the result in the form of a report.

FORMAT AND STANDARDS FOR LABORATORY ASSIGNMENTS

1. Laboratory reports and other hand-in assignments are expected to conform to the format and standards described and illustrated below. Use computer word processor for project reports.

2. Must have a title page, which should contain the following information:
   a. Project title or assignment title.
   b. Student's full name (please print)
   c. Course number
   d. Division number
   e. Due date
   f. Actual Date of Assignment Submission
3. Physical layout of the control circuit or process.
4. Description of the problem being solved using PLC.
5. Ladder logic diagram (print out of the ladder diagram).
6. Description of logical operation of the problem using ladder diagram.
PARKING LOT CONTROLLER USING ARITHMETIC/LOGICAL INSTRUCTION

OBJECTIVE

A parking lot can accommodate 20 cars. A counter system needs to be design using A-B PLC-5. The parking lot has one entry and one exit gate. If a car enters or leaves the parking lot a signal is sent to PLC-5 and thus it will keeps track of the number of cars in the parking lot. If at any time the parking lot is full (car = 20), the system will inhibit cars to enter the parking lot. A parking-lot-full-indicator light will also light-up. DO NOT use the counter instruction in writing this LADDER program.

LABORATORY ASSIGNMENTS

- Design ladder logic diagram.
- Connect PLC to motor, motor power circuit, and other necessary items for proper operation of the system.
- Debug and document the result in the form of a report.

FORMAT AND STANDARDS FOR LABORATORY ASSIGNMENTS

1. Laboratory reports and other hand-in assignments are expected to conform to the format and standards described and illustrated below. Use computer word processor for project reports.

2. Must have a title page, which should contain the following information:
   - Project title or assignment title.
   - Student's full name (please print)
   - Course number
   - Division number
   - Due date
   - Actual Date of Assignment Submission

3. Physical layout of the control circuit or process.
4. Description of the problem being solved using PLC.
5. Ladder logic diagram (print out of the ladder diagram).
6. Description of logical operation of the problem using ladder diagram.
START-FORWARD-STOP-REVERSE CONTROL

OBJECTIVE

Design a ladder logic using Allen-Bradley PLC - 5 that will control a forward and reversing action of a DC motor. Four switches are required to perform this control - start, stop, forward and reverse switches. The stop switch is normally close and others are normally open. A relay contact, C1, control the motor to run in forward direction and relay contact, C2, control the reverse direction of the motor. Once the motor is turn on and running in one direction, forward or the reverse switch is not functional. In order to change direction of rotation of the motor the stop switch must be pressed, followed by reverse switch. The operation of the motor can be summaries as follows:

START → FORWARD ↔ STOP ↔ REVERSE

LABORATORY ASSIGNMENTS

- Design ladder logic diagram.
- Connect PLC to motor, motor power circuit, and other necessary items for proper operation of the system.
- Debug and document the result in the form of a report.

FORMAT AND STANDARDS FOR LABORATORY ASSIGNMENTS

1. Laboratory reports and other hand-in assignments are expected to conform to the format and standards described and illustrated below. Use computer word processor for project reports.

2. Must have a title page, which should contain the following information:
   a. Project title or assignment title.
   b. Student's full name (please print)
   c. Course number
   d. Division number
   e. Due date
   f. Actual Date of Assignment Submission

3. Physical layout of the control circuit or process.

4. Description of the problem being solved using PLC.

5. Ladder logic diagram (print out of the ladder diagram).

6. Description of logical operation of the problem using ladder diagram.
FORWARD AND REVERSE CONTROL

OBJECTIVE

The ladder logic designed in Laboratory #5 is to control a D.C motor action forward-stop-reverse. For this laboratory the ladder logic to be designed will require the stop switch be activated before another selection is made. The stop switch is normally closed and other switches (start, forward and reverse) are normally open. A relay contact, C1, control the motor to run in forward direction and a relay contact, C2, control the motor to run in the reverse direction.

Part I: Modify ladder logic of laboratory #5 such that the motor can be control to rotate in the forward and reverse direction without pressing the stop switch. Make sure C1 and C2 contact are not energized at the same time, because that will shortcircuit the power source.

Part II: Modify the program in Part I such that C2 energizes 0.1s after C1 and vise versa. This inhibits short circuit between power lines.

The operation of the motor can be summaries as follows:

| STOP | ← | FORWARD | ← | START | ← | REVERSE |

LABORATORY ASSIGNMENTS

- Design ladder logic diagram.
- Connect PLC to motor, motor power circuit, and other necessary items for proper operation of the system.
- Debug and document the result in the form of a report.

FORMAT AND STANDARDS FOR LABORATORY ASSIGNMENTS

1. Laboratory reports and other hand-in assignments are expected to conform to the format and standards described and illustrated below. Use computer word processor for project reports.

2. Must have a title page, which should contain the following information:
   a. Project title or assignment title.
   b. Student's full name (please print)
   c. Course number
   d. Division number
e. Due date
f. Actual Date of Assignment Submission
3. Physical layout of the control circuit or process.
4. Description of the problem being solved using PLC.
5. Ladder logic diagram (print out of the ladder diagram).
6. Description of logical operation of the problem using ladder diagram.
OBJECTIVE

Large 3-phase induction motors are generally started as star connection and transferred to delta connection during normal running of the motor. Since it takes several seconds for the large motor to start, the switching from star to delta takes place approximately after 15 second from the initial closing of the start switch. Convert the following star-delta motor starter circuit to PLC controlled star-delta motor starter. Include the following safety features to the ladder program.

Extra safety features:
C2 contact, should be energized before main contact, C1, is energized. The closing delay between C2 and C1 is 2 second.

When switching from star, C2 contact, to delta, C3 contact, the main power should be OFF for 0.3 second to avoid short circuit.

CONTROL CIRCUIT
POWER CIRCUIT

LABORATORY ASSIGNMENTS

- Design ladder logic diagram.
- Connect PLC to motor, motor power circuit, and other necessary items for proper operation of the system.
- Debug and document the result in the form of a report.

FORMAT AND STANDARDS FOR LABORATORY ASSIGNMENTS

1. Laboratory reports and other hand-in assignments are expected to conform to the format and standards described and illustrated below. Use computer word processor for project reports.

2. Must have a title page, which should contain the following information:
   a. Project title or assignment title.
   b. Student’s full name (please print)
   c. Course number
   d. Division number
   e. Due date
   f. Actual Date of Assignment Submission

3. Physical layout of the control circuit or process.

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4. Description of the problem being solved using PLC.
5. Ladder logic diagram (print out of the ladder diagram).
6. Description of logical operation of the problem using ladder diagram.
FAULTY OCCURRENCE TIMER

OBJECTIVE

In an industrial process, occurrence of a fault needs to be monitored. The exact time of fault occurrence need to be recorded by employing PLC-5/25. The occurrence of the fault is triggered by opening of a normally close pressure switch. A timer could be built using retentive timer and counter instructions. The ‘timer’ is a 24 hours clock with minutes and seconds. A SET light indicates the active condition of the timer and a trip light indicated the occurrence of the fault. The timer is activated by a reset switch and a pressure switch initiates the trip condition. Design ladder diagram for the controlling of the process.

LABORATORY ASSIGNMENTS

• Design ladder logic diagram.
• Connect PLC to pressure switch, and other necessary items for proper operation of the system.
• Debug and document the result in the form of a report.

FORMAT AND STANDARDS FOR LABORATORY ASSIGNMENTS

Homeworks, projects and other hand-in assignments are expected to conform to the format and standards described and illustrated below. Use computer word processor for project reports.

[1] Must have a title page, which should contain the following information:
   (a) Project title or assignment title.
   (b) Student’s full name (please print)
   (c) Course number
   (d) Division number
   (e) Due date

[3] Description of the logic problem being solved using PLC.
OBJECTIVE

AN INDUSTRIAL PROCESS CONTROL SYSTEM

The sequence of the above process needs to be controlled. The process should be started by pressing a START switch and can be stopped by pressing a STOP switch. Both start and stop switches are momentary contact type switch. The float switches are both normally opened (NO) and both the solenoid are energized to open. The sequence of the process should be as follows:

First the FILL SOLENOID will open as soon as the start switch is pressed allowing fluid A to flow into the tank. As soon as the fluid level reaches 2nd (upper) float switch FILL SOLENOID must closed and AGITATOR motor will start and the agitator should run for 2 minutes. As soon as the agitator stops, EMPTY solenoid will open and empty the processes fluid from the tank. The EMPTY SOLENOID remain open until the tank level comes down to 1st (lower) float switch. Once the tank is empty, the process should wait for another manual start of the process.

There are two ways the process can be controlled using PLC. First, by using single ladder program which is the main ladder program and second, using sequential function chart (SFC). The ladder logic program using the first method is given in Figure 10-1. In this
laboratory experiment you are going to use the earlier method to control the process. In laboratory #10 you will learn to use the SFC to control the process.

LABORATORY ASSIGNMENTS

- Design ladder logic diagram.
- Connect PLC to motor, motor power circuit, and other necessary items for proper operation of the system.
- Debug and document the result in the form of a report.

FORMAT AND STANDARDS FOR LABORATORY ASSIGNMENTS

1. Laboratory reports and other hand-in assignments are expected to conform to the format and standards described and illustrated below. Use computer word processor for project reports.

2. Must have a title page, which should contain the following information:
   a. Project title or assignment title.
   b. Student's full name (please print)
   c. Course number
   d. Division number
   e. Due date
   f. Actual Date of Assignment Submission

3. Physical layout of the control circuit or process.
4. Description of the problem being solved using PLC.
5. Ladder logic diagram (print out of the ladder diagram).
6. Description of logical operation of the problem using ladder diagram.
OBJECTIVE

AN INDUSTRIAL PROCESS CONTROL WITH ADVANCE FEATURES

The sequence of the above process needs to be controlled. The process should be started by pressing a START switch and can be stopped by pressing a STOP switch. Both start and stop switches are momentary contact type switch. The float switches are both normally opened (NO) and both the solenoid are energized to open. The sequence of the process should be as follows:

First the FILL SOLENOID will open as soon as the start switch is pressed allowing fluid A to flow into the tank. As soon as the fluid level reaches 2nd (upper) float switch FILL SOLENOID must closed and an AGITATOR motor will start and the agitator should run for 2 minutes. As soon as the agitator stop, EMPTY solenoid will open and empty the process fluid from the tank. The EMPTY SOLENOID remain open until the tank level comes down to 1st (lower) float switch. Once the tank is empty, the process should wait for another manual start of the process.

There are two ways the process can be controlled using PLC. First, by using single ladder program which is the main ladder program and second, using sequential function chart (SFC). The ladder logic program using the first method is given in Figure 10-1. In this laboratory experiment you will learn to use the SFC to control the process given above.

Two parts are involve in generating a sequential function chart (SFC) to control this process.
ECET 262 PROGRAMMABLE LOGIC CONTROLLERS

- Building SFC blocks which contain Step and Transition files.
- Design ladder logic diagrams to correspond the Step and Transition files.

LABORATORY ASSIGNMENTS

- Design ladder logic diagram.
- Connect PLC to motor, motor power circuit, and other necessary items for proper operation of the system.
- Debug and document the result in the form of a report.

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ANALOG INPUT AND OUTPUT COMMUNICATION USING PLC 5 FOR INDUSTRIAL CONTROL APPLICATIONS

OBJECTIVE
In this experiment you are going to use Analog Input and Analog Output module. The objective of this experiment is to communicate with analog world with PLC 5.

Parts/Equipment:
- PLC-5 Lab station. Each PLC 5 laboratory station (P-112) has one analog input and one analog output module.
- Process calibrator to produce and measure both 0-5 VDC and 4-20 mA control signals.

Assignment:
- Write appropriate ladder logic using BTR and BTW commands. Connect analog input and output module of PLC 5 station to perform the communication with analog world. You may need other external components to perform this experiment.
- Troubleshoot the ladder logic and the external circuit and record the result in the form of a report.

Steps #1:
Start by entering the attached ladder diagram into your PLC Ladder logic software. Next to your ladder diagram window there is another window.
Step #2:
In the next window you want to enter the following settings:
Chassis Type: 1771-A3B (12 slots)
Adapter: (choose the adapter to match the one on your PLC station)
Rack Addressing: 2 Slots

To do that you have to double click on the first line and go to another window where you can select the Chassis Type:

and change the Rack Addressing from the DIP Switches list as follows:

Leave the rest as it is and click OK button

Step #3:
Double click anywhere else on the I/O configuration menus first line to come to the next configuration window as follows:
Go down to slot 6 where R/G/S/C = 0/3/0/0 and double click on the cell next to it to configure the Module Type and you will arrive at the following window:

Scroll down and choose 1771-IFE – 12 Bit Analog Input:
Click OK and you will go back to the previous window:
Step #4
Double click on the I/O Points on the same line and you will get the following:

<table>
<thead>
<tr>
<th>Internal Name</th>
<th>Description</th>
<th>Address</th>
<th>Required?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 BTRControl</td>
<td>Block Transfer Read control block</td>
<td>N100:0</td>
<td>Required</td>
</tr>
<tr>
<td>2 BTWControl</td>
<td>Block Transfer Write control block</td>
<td>N200:0</td>
<td>Required</td>
</tr>
<tr>
<td>3 InputData</td>
<td>Read data block</td>
<td></td>
<td>Required</td>
</tr>
<tr>
<td>4 OutputData</td>
<td>Write data block</td>
<td></td>
<td>Required</td>
</tr>
<tr>
<td>5 Configure</td>
<td>Block Transfer Write configure bit</td>
<td>N11:20</td>
<td>Optional</td>
</tr>
</tbody>
</table>

Enter the following configuration in ( The configuration can also be taken from the input block in your ladder diagram ):
BTRControl address: N100:0
BTWControl address: N200:0
InputData address: N11:0
OutputData address: N11:20
after you enter the numbers don’t press enter or you will go to Auto-Pick configuration. You have to use the mouse to click on the Done button

Once you click the Done button you will be prompted to save your configuration. Choose Yes to go to the next window:

Does configuration data already exist in the Data Table for this module? [Answering no will result in default config data being written]

Yes No
You can always go back to change any address mistakes you have made by clicking on the address column:

the only change you have to make here before to click on Accept Edit is:
Raw Max = 4096
After you click on Accept Edits you will get the following prompt. Click on Yes:

Next you will get back to the following screen. I/O Points = 16 indicating that it has been edited:
Step #5
On the screen above click on the cell that is highlighted on Slot 7 & R/G/S/C = 0/3/1/0 to get to the following screen:

Scroll down and pick 1771-OFE – 12 Bit Analog Output and click on OK
You will get back to the following window:

Click on the I/O points cell on Slot 7 to get to the following window
Enter the numbers as indicated in the following screen and click on Done (The addressing info can be found on the ladder diagram)
You will get to the screen below. You can always go back by click on the address column in the table:

Change the Module Type to OFE2 (4-20 mA version) as follows:

Enter the value of Raw Max = 4096 and click on Accept Edit
On the OFE box click on Yes.

<table>
<thead>
<tr>
<th>Channel</th>
<th>Symbol</th>
<th>Description</th>
<th>Address</th>
<th>Type</th>
<th>Data</th>
<th>DAC Input</th>
<th>Current Range</th>
<th>Raw Min</th>
<th>Raw Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>Write data block</td>
<td>N11.62</td>
<td>WORD</td>
<td>0</td>
<td>0</td>
<td>4 to 20 mA</td>
<td>0 0</td>
<td>4096</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>N11.63</td>
<td>WORD</td>
<td>0</td>
<td>0</td>
<td>4 to 20 mA</td>
<td>0 0</td>
<td>4096</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>N11.64</td>
<td>WORD</td>
<td>0</td>
<td>0</td>
<td>4 to 20 mA</td>
<td>0 0</td>
<td>4096</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td>N11.65</td>
<td>WORD</td>
<td>0</td>
<td>0</td>
<td>4 to 20 mA</td>
<td>0 0</td>
<td>4096</td>
</tr>
</tbody>
</table>

Step #6
Your configuration is done. You can download you ladder diagram to the PLC and see that your experiment is already started running.

Before you can see the communication between analog input and analog output module, you need to connect 1-5 VDC source to analog input module and 4-20 mA processor calibrator or ammeter to the analog output module.

Look for configuration and other pertaining information regarding analog input and analog output module attached along with this laboratory handout.

LABORATORY ASSIGNMENTS
- Design ladder logic diagram.
- Connect PLC to motor, motor power circuit, and other necessary items for proper operation of the system.
- Debug and document the result in the form of a report.

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