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Design and Development of a Low-Cost PLC Trainer Using Siemens Logo for Educational Purposes

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ABSTRACT

Due to the significant importance of PLC in the industries, there are many PLC trainers that available in the market, but they are very expensive. However, in many cases, the cost of providing class-quantity PLCs for student laboratory use is prohibitive. So the main goal of this article is to design and develop a low-cost PLC trainer. The hardware of the proposed PLC trainer consists of PLC (Siemens LOGO) unit, 220V AC 60Hz power supply, connected to a switch (on/off), then a fuse as a protection, after that the PLC was connected to the line, neutral, 8 input (4 solid switches and 4 bush buttons) and 4 relay output. It was installed and coordinated on a panel made of aluminum and plastic due to its low cost and light weight and it is installed with thick enough bases to carry the panel. The total cost of the developed trainer is about 500 US Dollars. In addition to being low cost, it is also characterized by ease of use, ease of programming and more portable. The developed training system gives one the flexibility to wire and program any type of inputs and outputs of one's choice. The paper is also meant to beginners and experienced PLC users to build themselves PLC trainers which can enhance their understanding of the theoretical knowledge. The experimental results prove the effectiveness of the proposed PLC trainer system.

1. INTRODUCTION

A programmable logic controller (PLC) is an industrial computer that receives inputs from switches and sensors, evaluates these inputs in accordance with programmed instructions, and controls output devices based on the results of this evaluation [1].

PLCs "have replaced hard-wired relay-based control systems in most industries because of their compact size, ruggedness, and, most importantly, their ability to be reprogrammed". Reprogramming a PLC allows changes to be made in the functional operation of a machine system without major physical changes in the control or output system components or wiring. Thus, labor, equipment, and downtime costs are reduced [2].

Areas where programmable logic controllers are applied and the importance of using PLC in the industry PLCs are used in various applications in industries such as the steel industry, automobile industry, chemical industry and the energy sector. The scope of PLCs dramatically increases based on the development of all the various technologies where it is applied. For example, the importance of using PLC in cement industry Manufacturing cement involves mixing various raw materials in a kiln. The quality of these raw materials and their proportions significantly impact the quality of the final product. To ensure the use of the right quality and quantities of raw materials, the accuracy of data regarding such process variables is of the essence [3]. Factory management professionals have written extensively on effective methods for teaching electrical concepts and skills. While specific curricula vary, all authors agree that effective electrical educational programs should provide students with active, hands-on learning experiences. These experiences are essential for both concept and skill development [4-5]. Therefore, it is important to link what students learn in theory with practical experience. But the PLC trainers is expensive. Therefore, design and development of a low-cost PLC trainer is an important issue.

In this paper, Design and Development of a Low-Cost PLC trainer using Siemens Logo for

Educational Purposes, the input voltage of 220VAC is connected to a switch (on/off), then a fuse as a protection, after that the PLC was connected to the line, neutral, 8 input (4 solid switches and 4 bush buttons) and 4 relay outputs. It was installed and coordinated on a panel made of aluminum and plastic due to its low cost and light weight and it is installed with thick enough bases to carry the panel.

DESIGN AND IMPLEMENTATION OF THE MODEL

After evaluating various manufacturers and models, was selected of the Siemens LOGO! 230 RCE Controller unit. The Logo! 230/24 RCE - 6ED1052-1FB08-0BA0 logic module from Siemens with color-changeable display in 3 colors has the protection rating IP20 and works with a power supply of 115/230 V AC. Up to 400 function blocks can be processed. The device has 8 digital inputs and 4 digital outputs (relays) available. The Logo! 230/24 RCE - 6ED1052-1FB08-0BA0 logic module with display is programmable via Ethernet interface. Moreover, it can communicate with other modules of the Logo! series and Simatic S7 devices. The integral web server applications allow wireless monitoring and control via smartphone, tablet or PC. In addition, user-defined web pages can be stored as visualizations. The Logo! 230 RCE - 6ED1052-1FB08-0BA0 logic module is used e. g. for machine controls in industrial and manufacturing processes, in building management technology, timing programs for traffic control systems as well as for use in pumps or filter systems. Special applications are also possible.

Fig.1: The Siemens LOGO! 230 RCE. [6]

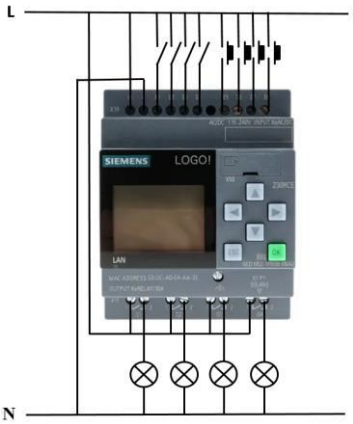


Fig.2: Wiring diagram for PLC panel.

In addition to the Siemens LOGO! Controller, several other items were required to construct the board (Table 1). These included a 220 V AC, 3ph input power, 4 On/Off Switches, 4 Push Button, 5 LED Indicator with difference colures (red, blue, white, orange and green), one power switch, fuse holder as protection, the components will be connected to each other by a cable and will install on panel board.

Table1: Materials and Price list for PLC panel.

Item	Quantity	Unit Price ($)	Total ($)
Siemens LOGO! 230 RCE Controller	1	168.5	168.5
On/Off Switch	4	5.8	23.2
Push Button	4	6.67	26.68
LED Indicator	5	7.63	38.15
Power Switch	1	6.67	6.67
Fuse holder	1	4	4
Cable	-	-	17.33
Panel board	-	-	160
		TOTAL	444.53 $

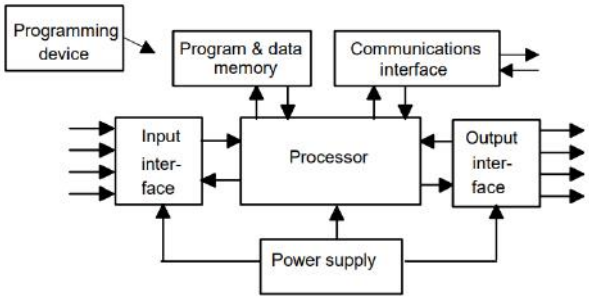


Fig.3: Block diagram for PLC panel. [7]

After selected the components, we started to make a wiring diagram (Figure 3). The input voltage of 220V AC is connected and disconnected by a switch (on/off), then a fuse as a protection, after that the PLC was connected to the line, neutral, 8 input and 4 output. It was installed and coordinated on a panel made of aluminum and plastic due to its low cost and light weight, as we mentioned earlier the low cost is our goal, and it is installed with thick enough bases to carry the panel, Fig.4 shows the PLC panel after installed.

Fig.4: Programmable logic control panel

2. RESULTS AND DISCUSSION

Now we will do some experiments to test the PLC board:

1.First Experiment: One input gives one output.

2.Second Experiment: One input gives multi outputs.

3.Third Experiment: Multi input connected together by OR block gives one output.

4.Fourth Experiment: Design of flashing lamp.

All experiments contain a table with the names of the blocks and their functions, an image to display the program and the results.

Experiment 1 - One input gives one output:

Device	Function
I1	Start/Stop switch
Q1	Blue lamp

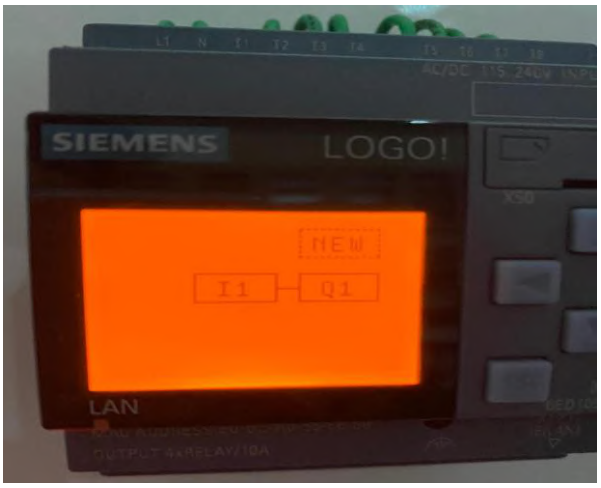


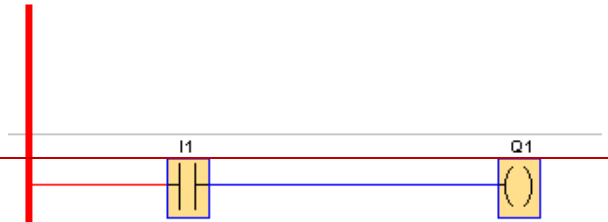
Fig.5: Program of experiment 1

Fig.6: Result of experiment 1

Experiment 2 - One input gives multi outputs:

Table 3: Blocks and functions of exp.2

Device	Function
I1	Start/Stop switch
Q1	Blue lamp
Q2	White lamp
Q3	Orange lamp
Q4	Green lamp



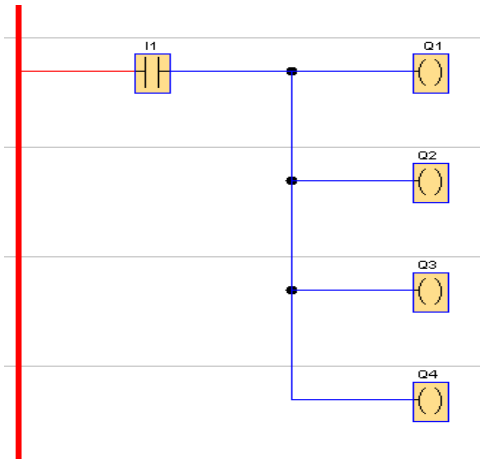


Fig.7: Program of experiment 2

Fig.8: Result of experiment 2

Experiment 3 - Multi input connected together by OR block gives one output:

Table 4: Blocks and functions of exp.3

Device	Function
I1	Input 1
I4	Input 2
B1	OR block
Q1	Blue lamp as output

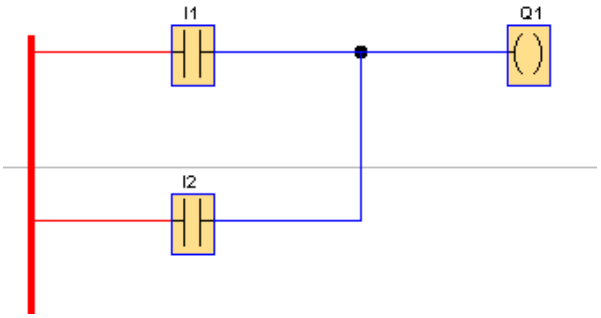


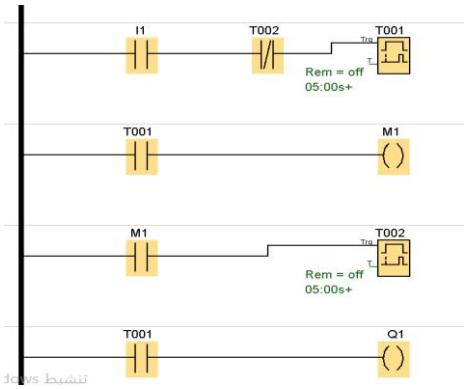
Fig.9: Program of experiment 3

Fig.10: Result of experiment 3

Experiment 4 - Design of flashing lamp (by used on delay timer):

Table 5: Blocks and functions of exp.4

Device	Function
I1	Start/Stop switch
Q1	Blue lamp
Q2	White lamp
Q3	Orange lamp
Q4	Green lamp



(d)

(a)

(e)

(b)

(f)

Fig.11: Program of experiment 4

(c)

(a)

(b)

Fig.12: Result of experiment 4

3. CONCLUSION

This paper presented the development of e-PLC, a low cost, easy-to-use PLC trainer that allows students to insert mnemonic codes and simulate the outcome using the built-in hardware. Result obtained shows e-PLC is fit for use. The objective of this project was to develop a low-cost PLC trainer with the addition of several other advantages. The total cost was approximately $500. The PLC trainer was tested and used to address some examples of experiments.

5. REFERENCES

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