

Programmable Logic Controller Trainer for Polytechnic Students

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Abstract

Innovation in education is always seeking knowledge that will support new and unique ideas in instructional techniques that will teach the students in more effective and exciting ways. The best way to learn Programmable Logic Controller (PLC) is to get hands-on experience. A low cost PLC trainer known as ProPLC has been designed, built and used for introducing PLC for students at Polytechnic Kota Bharu. Other than introducing student to industry standard component, the trainer also will interpret industrial wiring diagram. As a result, students are better prepared for industrial design regarding PLC controlled manufacturing equipment.

Keywords: - Programmable logic controller, ProPLC

1. Introduction

A programmable logic controller (PLC) is a solid state system designed to perform the logic functions previously accomplished by components such as electro-mechanical relay, sensors, switches, mechanical timers/counters, etc, for the control and operation of manufacturing process equipment and machinery. They are a form of computer that is frequently used in commercial and industrial applications to monitor inputs, make decisions based on a program, and control outputs to automate a process or machine.

A programmable logic controller (PLC) or programmable controller is an industrial digital computer that rugged. PLC used for controlling manufacturing processes, such as assembly lines, robotic devices, or any activity that requires high reliability, ease of programming and process fault diagnosis. PLCs can range from small modular devices with tens of inputs and outputs (I/O), in a housing integral with the processor, to large rack-mounted modular devices with thousands of I/O, and which are often networked to other PLC and SCADA systems.

PLC making industries heavily reliant on higher education. Furthermore, requirement for working in automation typically need electrical and machining knowledge. Various control operations are to be performed automatically and sequentially on the electrical machines to suit the industrial requirements. Programmable controllers are mainly employed to control the process in industries. In order to impart knowledge on programmable logic controller this trainer is developed.

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students in Electrical Engineering, Polytechnic Malaysia provides knowledge regarding the concept and principle of automation system. This course emphasizes the relationship between conventional method and PLC system. Application of various industrial input and output devices of PLC, designing process, programming, constructing, wiring and PLC maintenance method included in the program. This paper describes non-commercial PLC trainer unit called ProPLC that allow students to do basic wiring and modify PLC programming.

ProPLC trainer is suitable for students to develop competence in operating, programming and troubleshooting modern plc control circuits. This trainer small in sizes, low cost to develop, suitable to give basic training package. A student experiment manual is provided to guide the student through the experiments. The experiments are chosen to cover the topics from basic familiarization of the PLC up to programming and applications. Besides that, the trainer developed was safe for students to use. The trainer allows application involving 12 input and 8 outputs.

2. Literature Review

One prototype trainer was built and successfully incorporated into a university agricultural electricity course fall 2004. A PLC Trainer with hands on Wiring was developed by Jack and Yanik (2018). The fabrication of compact portable kits has been designed and built by Maarif and Suhartinah (2018). Development of a Programmable Logic Controller Training Unit for Engineering Technology Curriculum by Davis et al. (2015). Commercial education PLC trainees are typically expensive and do not have complete flexibility. They are usually

stacked with fixed modules, limited interface options, and older PLCs. The purpose of this master’s project is to design and build trainees that overcome these limitations by utilizing the full power and operational capabilities of PLCs with newer processors. Therefore, it was decided to incorporate Allen Bradley’s commercial SLC-503 programmable logic controller into the trainer. This PLC was chosen because of its 16K-word on-board memory and wide application for controlling systems and processes in the industry.

3. Methodology

Commonly, the existing trainer for PLC are very expensive and the wiring method cannot be explained to students. The primary disadvantage of the original systems was the hardware was preconfigured, thereby representing a closed-box training unit. As a result, the students were only responsible for developing ladder diagram and did not understand the wiring method connected to the input and output module. This resulted in many missed learning opportunities that could have been designed into the lab activities or introduced by the student themselves. This project is targeted to design a compact unit and provide competitive cost for manufacturing and reliable. Figure 1 show the research method.

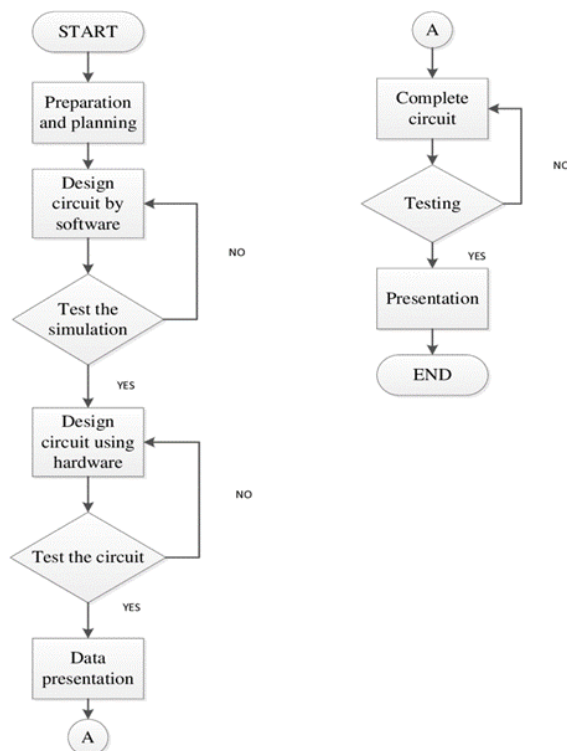


Figure 1: Research method

This research is focused on the design, assembly and testing. The trainer build using PLC controller model CP1E NA-20-DR-A built in 12 inputs and 8 outputs (Relay Output Type). The trainer is flexible systems ideally suited as teaching assistant. This trainer is suitable for the students to develop competence in operating, programming and troubleshooting modern PLC control circuits. A student experiment manual is provided to guide the students through the experiments. The experiments are chosen to cover the topics from basic familiarization of the PLC up to programming and applications.

Table 1: Detail of The Component.

No	Assignment	Component	Specification	Quantity
1.	Controller	PLC Omron CP1E-N20R	Supply 220V AC 24V DC Relay output	1
2.	Input	Toggle Switch Limit Swith Push Button		4
3.	Output	Pilot light Fan	24V	3
4.	Supply	Power Supply	240V 10A	1
5.	Casing	Black box		1

4. Finding and Analysis

The PLC trainer designed known as ProPLC using Omron CP1E shown in Figure 2.

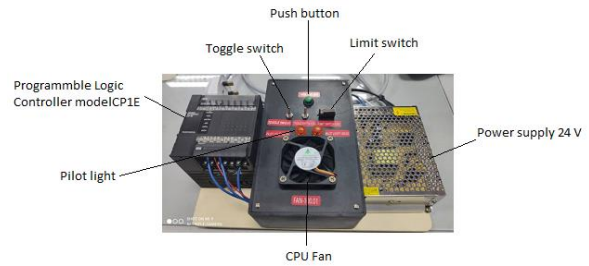


Figure 2: ProPLC trainer

ProPLC designed with low cost, besides small in size to save space. Furthermore, the trainer is rugged and designed to withstand vibrations, temperature, humidity and noise. The trainer has a few spare inputs and outputs, these allow extra input and output to be added. ProPLC is provided with simple programming method to program the PLC. This model can be brought anywhere due to light weight.

The development of the training unit was using the component list in Table 1.0. The block diagram for the PLC trainer shown in Figure 3. The most important, the trainer developed is ‘open’, where students were left to develop the system to achieve the learning outcomes. Students will get opportunity to learn trade skills such as industrial wiring, troubleshooting and safety. The trainer can representative of the current state of technology and capable of adequate.

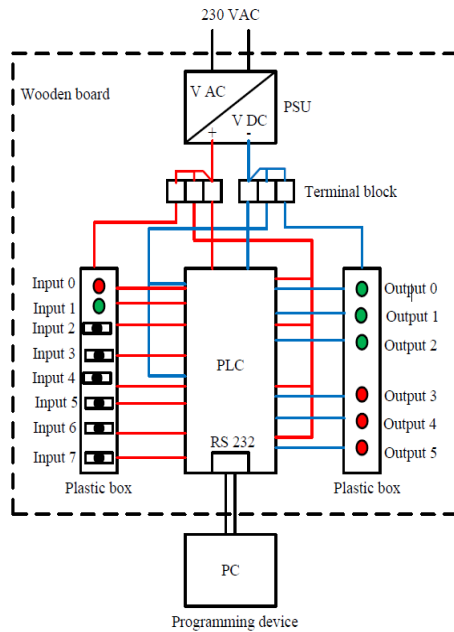


Figure 3: Block diagram for the PLC trainer

The training equipment is consisted of various kind of electrical switch as input, programmable logic controller (PLC), power supply also pilot light and small fan as output as shown in Figure 4.

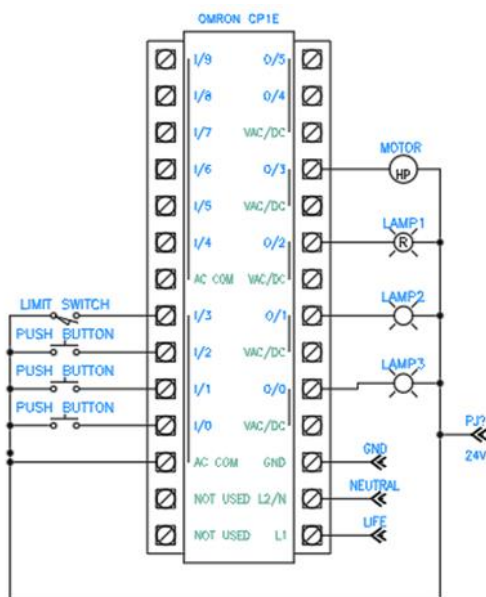


Figure 4: Trainer input and output wiring

According to related experiment, student can understand functions of timer, counter, understand the connection method, master the PLC programming technique. Consequently, it can cultivate student corresponding knowledge and technical ability. As a result, the trainer suitable for teaching technical ability training of related

specialties of higher vocational college, polytechnic, college and university.

This Mobile PLC Trainer offers a platform that enables students to perform a comprehensive range of programming tasks culminating in the control of the unit using an industrial programmable logic controller (PLC). Students develop their understanding of PLC programming using our unique software (Cx Programmer) simulation of an industrial work-cell. The trainer is housed in a waterproof case for ease of transportation and shipping. Open system, ready to communicate with personal PC. Easy to program and portable. Shortage-circuit protection. The PLC Trainer Is a complete training system, introducing the student to the operation, programming and troubleshooting of modern industrial programmable logic controllers. A high performances multi-purpose PLC controller (CP1E) designed for all kinds of automated equipment. The PLC Trainer learning materials have been designed to provide practical real-world problems solving tasks and activities within the classroom or lab environment.

4.1 Testing Input and Output of The Trainer

The movement of the controlled system is constantly monitored by the input devices that give a specified condition and send a signal to the programmable controller. Firstly, determine the input and output to be connected to the programmable controller. The input devices are the various switches, sensors, etc. The output devices are the solenoids, indicators, fan, lamp, etc. After identifying all the various Input and Output devices, assign the number of numbers corresponding to the Input and Output number of the programmable controller on the trainer. The actual wiring will follow the number of the programmable controller. The assignment of Input and Output numbers must be carried out before writing ladder diagram because the number dictate what is the precise meaning of the contact in the ladder diagram. After completing a ladder diagram, power to programmable controller can be apply. Before the start push button is pressed, Input and Output wiring are correctly connected to the Input and Output assignment. After confirmed, the actual operation of the PLC can be started.

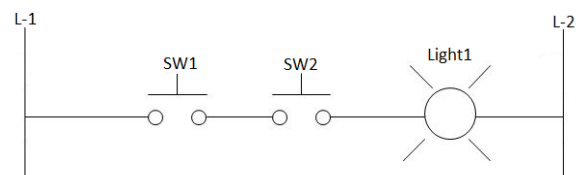


Figure 5: Example of ladder diagram

5. Conclusion

The objective of this project is to develop a low-cost PLC trainer that could be successfully integrated into Programmable Logic Controller and Automation course in Electrical Engineering Department, Polytechnic Kota Bharu. Other than that, the trainer more portable for PLC training due to light weight. Students gained an average knowledge improvement of wiring and programming the PLC on their own. Cost for developing the training unit was relatively low and small in size. This innovation project is not only suitable for use in the Department of Electrical Engineering, Kota Bharu Polytechnic but also for all Malaysian polytechnics (33 polytechnics) and Malaysian Community Colleges (79 Malaysian Community Colleges). This project can also be applied in IPTA and IPTS in the field of Electrical Engineering or Mechanical Engineering. This project also has the potential to be commercialized for all educational institutions either locally or international.

Acknowledgment

All praises to Allah and His blessing for the completion of this paper. I thank Allah for all the opportunities, trials and strength that have been showered on me to finish writing the innovation project. I experienced so much during this process, not only from the academic aspect but also from the aspect of personality. My humblest gratitude to the holy Prophet Muhammad (Peace be upon him) whose way of life has been a continuous guidance for me. My deepest gratitude goes to all of my family members. It would not be possible to write this paper without the support from them. Last but not least, to all my friends at Polytechnic Kota Bharu.

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