# Implementation of PLC and HMI Experiments for a Final Year Course

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*Abstract* — This paper presents a method of preparing Programmable Logic Controller (PLC) and Human Machine Interface (HMI) experiments for a final year course. The students are taught with the up to date technology for monitoring and control using in industry. Although PLC was rapidly introduced into modern SCADA systems for monitoring and control of industrial processes, other applications, cost and specific skill may be required to set up modern SCADA laboratory. Therefore, institutes and instructors may be reluctant to do it. So the student can be completed the basic experiments at the laboratory after the final year course.

*Keywords—PLC; HMI; teaching and learning; engineering education.*

## I. INTRODUCTION

The final year course covers a wide range of topic from electronic circuit, signal and system, communication, control theories, software engineering and design. It is vital to the monitoring and control of the industrial control systems, like electrical power generation, transmission and distribution, other production and processing. Therefore, the student gain insight to the subject will enable them to explore many job opportunities when they graduate. Since PLC and HMI course is a huge topic for the final year electronic engineering students, some instructors may prepare laboratory experiments based on their experiences and knowledge. The laboratory works provide for student, significant practical experience in identification, selection and programming of needed to analyze and design system.

Since 2015, some engineering programme in Myanmar was attempting to be accredited by the Engineering Accreditation Council. Therefore, the University and department began the documentation process how program outcomes (PO) would be achieved and the instructors set up the action plan for continuous quality improvement in the course for the final year students. In the action plan, the instructors decided to increase the percentage of the assessment to more advanced laboratory works relating to the PLC and HMI.

This paper includes the description of a PLC based control system. The details on how to set up a cost effective PLC and HMI experiments are proposed.

## II. PLC

Students are briefed on what is PLC and how to program PLC using Ladder Diagram during the lecture. Teaching PLC without any laboratory does not mean anything. Therefore, Siemen PLC module and its software were used in the laboratory to accomplish some of their laboratory tasks.

Totally Integrated Automation (TIA) software is a unique basis offered by Siemens for uniform and customized automation in all sectors of the production, process and hybrid industries. TIA offered a uniform automation technology on one single platform for all applications of process automation.

### A. Laboratory Experiment I

This experiment is to introduce the students to the concepts of truth table, logic circuits, and ladder diagram with the latches, timer, counter, shift register, etc.,. By completion of this, students will familiar with how to use TIA Portal software from Siemen, for developing the program. Students will be able to input signal from the external devices, such as switches and sensors, and output instruction to the actuator and lighting. Besides this, students will practice how to create Ladder Diagram. For this experiment, the student's lab report must be put to the instructor during the limited time. The students will show the testing the ladder programming with the software at the Figure (1).
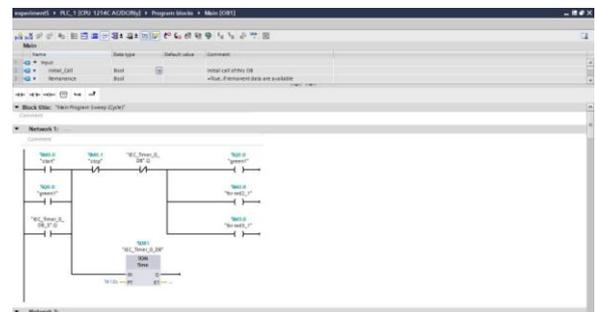


Figure 1: Testing the ladder diagram programming with the TIA Portal software

### B. Laboratory Experiment II

The purpose of this experiment is to bring students' PLC knowledge in contact with a real-world example. Students create a PLC program that allows for coordinated operation of the process. In this experiment, students make the program for the complex traffic control system. Figure (6) shows the flowchart of the traffic control system to present the concept of this system. Figure (2) to (5) show the creating the program to process this control system and the tag table to monitor this system.
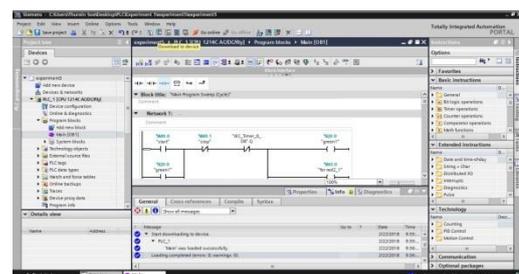


Figure 2: Creating the PLC program for the traffic system and downloading the program to the device
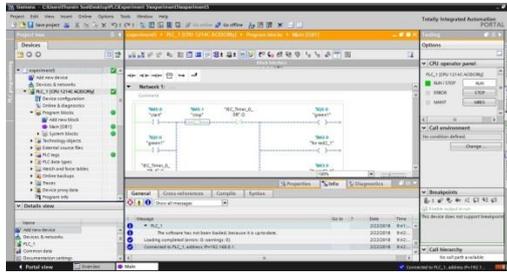
Figure 3: Monitoring the traffic system with the simulation tool
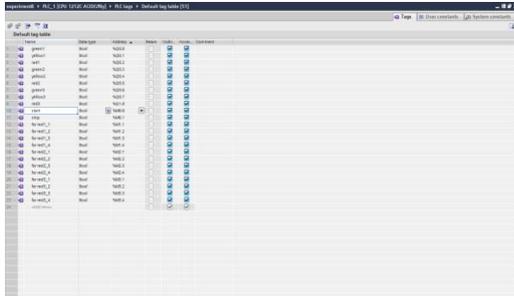


Figure 4: Creating the tag table to monitor the traffic system
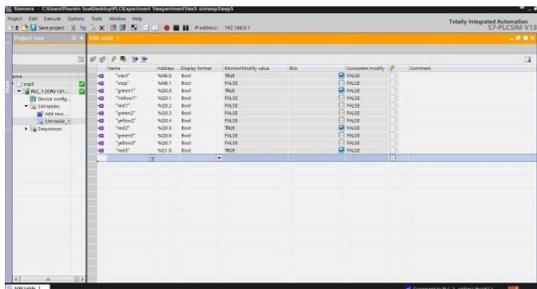


Figure 5: Motoring the traffic control system with the tag table

### III. HMI

Terminology, concepts, principles, procedures, computations, and communication protocols used in the control field programming are studied. The programming of the human machine interface (HMI) presents the process data to a human operator. The HMI provides the transparency needed between the operator, who works in environments where the processes are becoming more complex, and the machine. The HMI system represents the interface between man (operator) and process (machine/plant).

#### A. Laboratory Experiment III

By completion of the experiment III, the students will be able to create the HMI panel that shows completely the process of the experiment II. Students will create the connection between the PLC and HMI, design some screens with basic buttons, define all necessary tags and assign them to buttons. The students show the HMI panel design, connecting the PLC and HMI, simulating the system, operating this system and monitoring the process on the HMI panel for the following Figure (7) to (12)
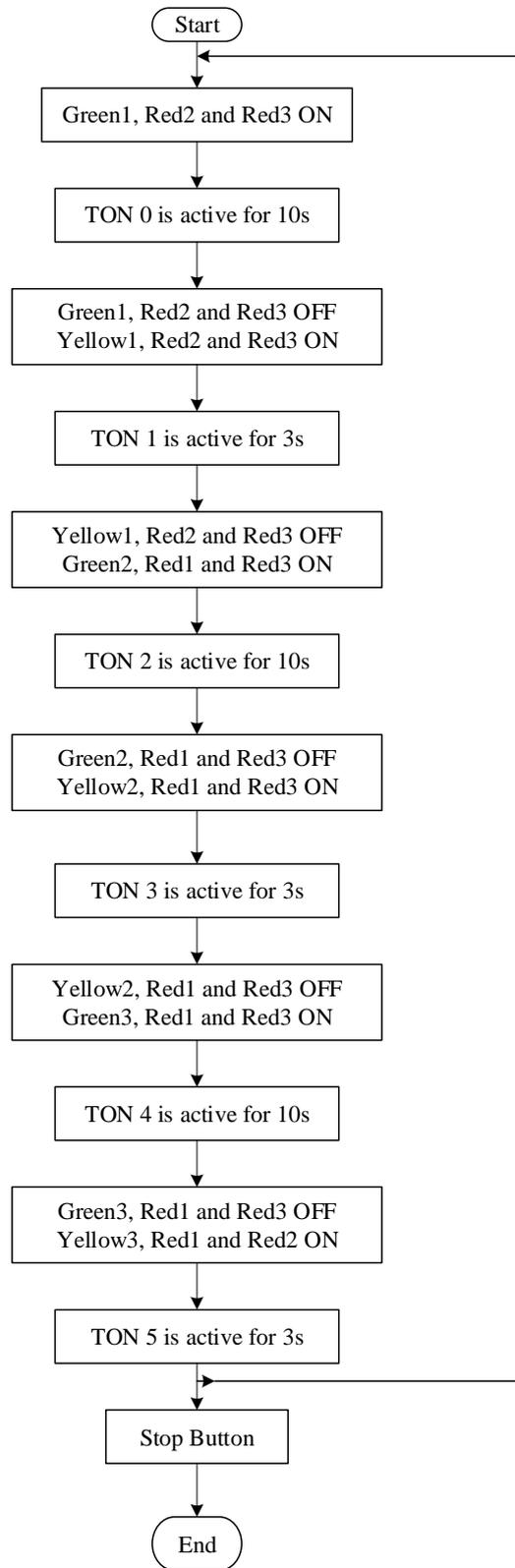


Figure 6: Process flow chart for the traffic control system

Start

Green1, Red2 and Red3 ON

TON 0 is active for 10s

Green1, Red2 and Red3 OFF
Yellow1, Red2 and Red3 ON

TON 1 is active for 3s

Yellow1, Red2 and Red3 OFF
Green2, Red1 and Red3 ON

TON 2 is active for 10s

Green2, Red1 and Red3 OFF
Yellow2, Red1 and Red3 ON

TON 3 is active for 3s

Yellow2, Red1 and Red3 OFF
Green3, Red1 and Red3 ON

TON 4 is active for 10s

Green3, Red1 and Red3 OFF
Yellow3, Red1 and Red2 ON

TON 5 is active for 3s

Stop Button

End



Figure 7: Creating the HMI Panel
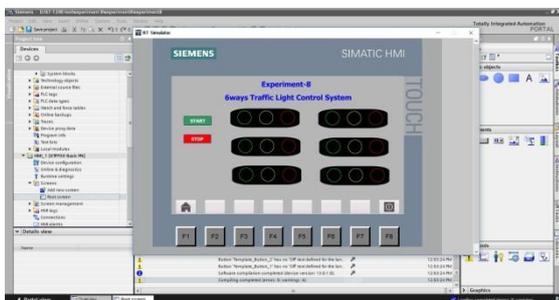
Figure 8: Simulation of HMI Panel Screen
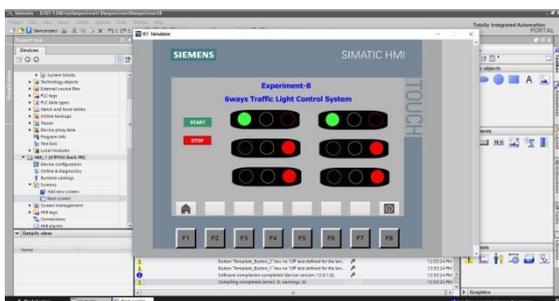


Figure 9: When press and release the start button, the Green1, Red2, Red3 and timer1
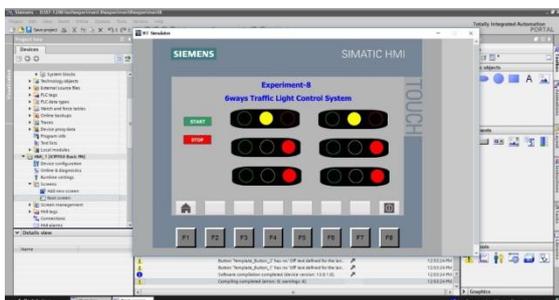


Figure 10: When timer1 is time up, the Yellow1, Red2, Red3 and timer2 are on
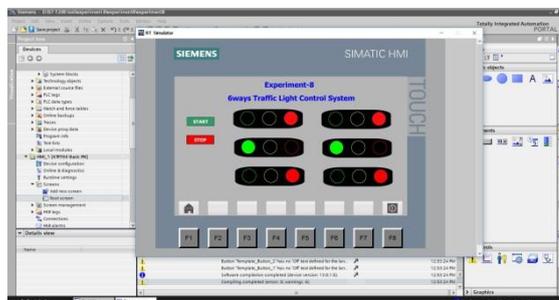


Figure 11: When timer2 is time up, the Red1, Green2, Red3 and timer3 are on
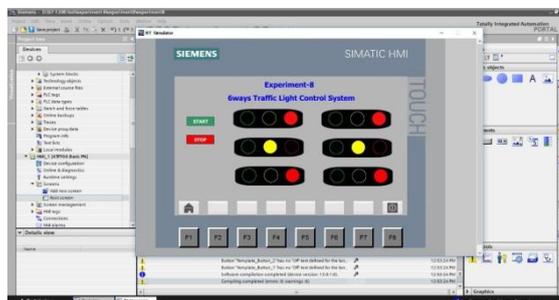


Figure 12: When timer3 is time up, the Red1, Yellow2, Red3 and timer4 are on

## CONCLUSION

It was observed that students were interested to learn more about PLC and HMI Course because they found it is relevant to the real-world applications and useful for them in future. In the lecture time and the laboratory, the students understand the topics of PLC and able to design the controller based on Ladder Diagram, most of them did not have any problem in implementing the controller on Siemen PLC module, using TIA portal. The concepts and software technologies used to develop the present application can be reused, to write many other similar control applications.

### References

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