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# Development of SCADA System in PLC Courses: Innovation in Teaching Methodology

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**Abstract:** This article is about the development of experimental or practical exercise on SCADA (Supervisory Control and Data Acquisition) system using Omron Programmable Logic Controller (PLC) courses at Port Dickson Polytechnic. SCADA is popular approach for HMI (Human Machine Interface) which can aid in monitoring a real time process, provide the control ability from remote and help in real time data collection. This practical exercise will benefits students with hands on skill in developing the SCADA system which widely used in industry.

**Keywords:** SCADA, HMI, Supervisory, Control, Data Acquisition, OMRON

## I. INTRODUCTION

SCADA systems is very important in industrial organizations where it provide the efficiency of machine, make the process and quality control in check and help in better productivity. It also helps in reducing machine downtime and safety control. It is not only used in a machine but can also been used in monitoring the whole complete system of production system. The ability to control the variables of process and provide output signal from remote give valuable reputations among industrial system. The basic SCADA system architecture always include PLC as the controllers or RTU (remote terminal units)

## II. COMPONENTS OF SYSTEM

The PLC used in this practical exercise is Omron types where it has serial communication ports to provide 2 ways communication between PLC which is programmed using CX Programmer and computer installed with CX Designer (SCADA system).

### A. CX Designer

CX Designer is incorporated software in Omron plc software to provide the graphical overview of our system. CX Designer is allow the students to choose the image of components, creating or import it from local data memory or server.

### B. CX Programmer.

CX programmer is the software to program all Omron's PLC series. It is integrated with CX designer which provide the algorithm or intelligent of our system. Type of the language used in programming the PLC in this exercise is ladder diagram.

## III.METHODOLOGY

There are 3 exercise designed for students to develop or creating their own SCADA system:

### A. To Switch ON and OFF the indicator Light

The objective of this exercise is to introduce students the overall flow of making the SCADA system using CX Designer.

Task: The indicator light will turn ON if push button is pressed and turn OFF if the button is released.

### Steps

- 1) Designing Ladder Diagram: The ladder diagram is created using CX Programmer software as shown in Figure 2. The address for the input labelled as I0.00 whereas output is labelled as Q0.00. The internal working relay W0.01 is put on parallel with I0.00 to perform the OR logic operations. This is to allow the output Q0.00 is energized either by physical push button which is wired to PLC or by pressing the button on SCADA designed in CX Designer.



Fig. 2 Ladder diagram

- 2) Creating SCADA graphical components using CX Designer: Once the ladder diagram is compiled and worked accordingly, the new file of CX Designer is created. The input which is pushbutton is chosen by clicking the PB icon and placed it on the canvas.
- 3) The Push button then placed on the appropriate location.
- 4) The tagging or labelling of the input or output components can be done by double clicking the components. The label can be edited in object comment space and the address for components can be assigned by clicking on Set icon. The address must be the same with components address in ladder diagram respectively.
- 5) The shape, colour of the object can be customized as preferred by user. This can be done by clicking the color/shape menu bar. The parts list is in the bitmap image format can be imported or draw by user. The user may determine the ON and OFF appearance of the components.
- 6) The output can be selected by clicking output icon. The output then dragged to the canvas and placed at proper location
- 7) Similar with the inputs components, the output components also must be labelled and addressed. The address for output begins with 10.00 follow by number of bits according to ladder diagram.
- 8) The colour and shape for the output components can be customized as mentioned in Figure 3.

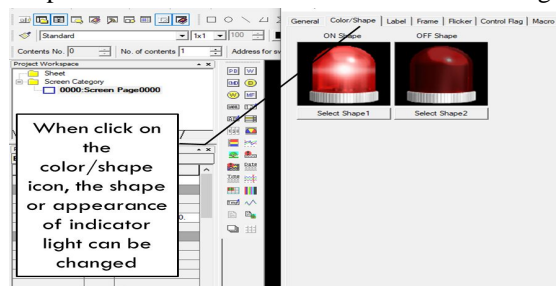


Fig. 3 Customizing output components.

- 9) The internal relay W0.00 is set as setting the input PB but area WR is selected instead of Common I/O. The respective address is set according to ladder diagram. The system can be test by clicking Tools menu and Test action is selected.
- 10) There are three options given to test the system. The first option is testing offline where the user may test the SCADA without link it to CX programmer. The second option is to test by integration with CX simulator, where the status of the ladder diagram can be monitored on CX Programmer while the SCADA on CX designer is in operations. The last option is to link the CX Designer with the physically connected PLC. By this option, we may observe the actual and the SCADA system can be monitored and controlled.
- 11) The indicator light will turn ON if the button on CX Designer is pressed. We may monitor both ladder diagram on CX programmer and SCADA on CX Designer at the same time.

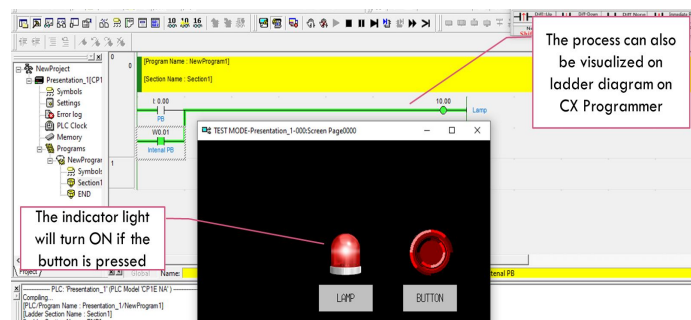


Fig. 4 The input and output can be simulated using tested SCADA

### B. To refill a Water Storage tank Using Pump

The objective of this exercise is to apply the latch (holding bits) and its SCADA in water storage system using CX Designer.

Task: Pump will start working and fill the tank if start button is pressed once and continue ON until Stop button is pressed.

- 1) The Steps for designing this SCADA is the same with practical 1 above.
- 2) The pump and piping system can share the same address which will turn ON and OFF simultaneously.

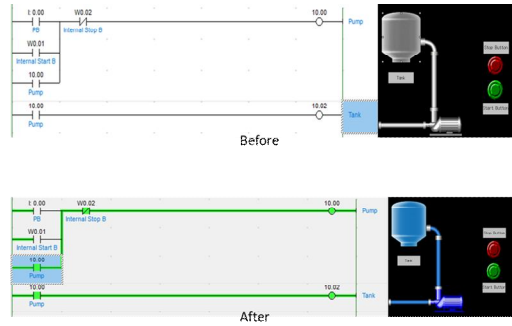


Fig. 5 The SCADA and ladder diagram before and after the start button is pressed

*C. To Simulate the Changes of Value such as Analog Input and Display it on the Scalable Output.*

The objective of this exercise is to allow students to apply the SCADA for displaying the change in value of data in PLC data memory location.

Task: Pump will start working and fill the tank if start button is pressed once and continue ON until Stop button is pressed. Once the pump is working, the water level is increase with certain increment rate for every 1 second pulse signal. The level of water in the tank is displayed and the pump will stop working if the stop button is pressed.

- 1) The Steps for designing this SCADA is the same with practical 1&2 above.
- 2) The pump and piping system can share the same address which will turn ON and OFF simultaneously.
- 3) The minimum and maximum level can be set at level icon in CX Designer.

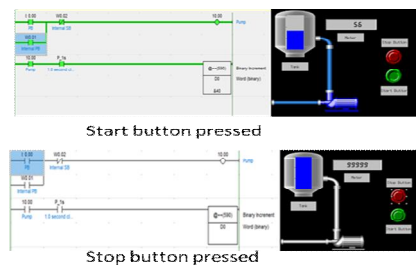


Fig. 6 The SCADA and ladder diagram after the start and after the stop button is pressed

**IV. CONCLUSIONS**

The exercise above that needs the students to create or customize their own SCADA system where it will give them an advantage on understanding the PLC programming better. It will provide them with fundamental knowledge on how the SCADA system works. This knowledge can be expanding to fulfill the needs of Industrial Revolution 4.0(IR4.0) which the machines and system can be monitored and control remotely via internet communication. This learning approach also, can be used in the situations where the physical PLC cannot be used such as limited number of equipment in the laboratory or the situations that need the students learn from remote such as in pandemic situation.

**V. ACKNOWLEDGMENT**

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