

Design and Implementation of PLC Program for Sequencing Movement of Three Pistons

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Abstract

This paper describes how the program is designed and implemented for sequencing movement of three pistons. This involves consideration of the software. A systematic design technique is considered steps by steps. The ladder programming method is used and written by logicpro software.

Keywords—*pistons; ladder; PLC; algorithm; sequence*

I. INTRODUCTION

Programmable Logic Controller (PLC) is a kind of computer that is specially designed for industrial control purpose. It can achieve continual or discrete control goals in many different environments. Originally, PLCs are the substitutions of relays in an industrial control system in the 1960s [1]. During that period, a programmable logic controller is commonly abbreviated as PC. However, the abbreviation has been changed to PLC in order to avoid misunderstanding the programmable logic controller as a personal computer.

A programmable logic controller (PLC) is a special form of microprocessor-based controller that uses a programmable memory to store instructions and to implement functions such as logic, sequencing, timing, counting and arithmetic in order to control machines and processes [2]. In order to control machines and processes, PLC is designed to be operated by engineers even by a limited knowledge of computers and computing languages[3].

The term logic is used because programming is primarily concerned with implementing logic and switching operations. Input devices, e.g, sensors such as switches, and output devices in the system being controlled, e.g. motors, valves, etc., are connected to the PLC. The operator then enters a sequence of instructions, i.e. a program, into the memory of the PLC[4].

II. DESCRIPTION

Three main programming devices can be found in the global market. They are Hand-held programming device, simple display-keyboard programming device and laptop computer. A hands-free programming device is shown in Figure 1. The programming language used in

this device is called Boolean. The display screen can only show one line of the program. Simple display-keyboard programming device, which is shown in Figure 2, consists of a screen and a keyboard. The function of this type of programmer is similar to a Human Machine Interface (HMI). Also, a laptop computer can be used as a programming apparatus. However, it requires a specific programming software to program the PLC. The PC based programming device is shown in Figure 3.



Figure 1 Typical Hand-Held Programming Device [1]

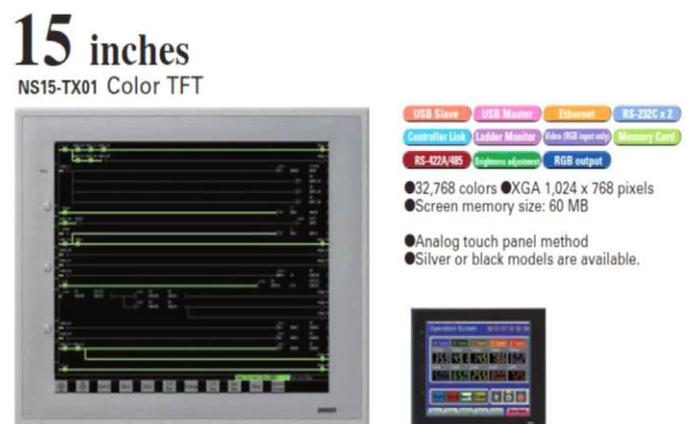


Figure 2 Simple Display Keyboard Programming Device [1]

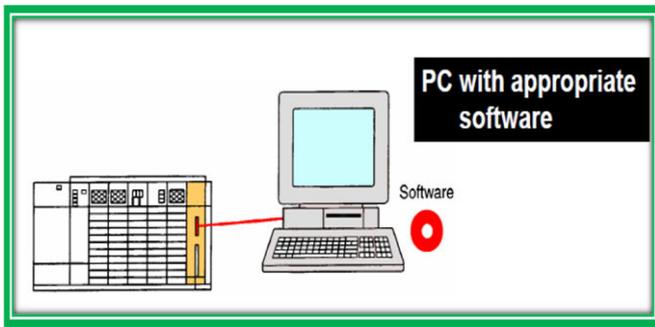


Figure 3. PC Based Programming Device [5]

As PLCs have developed and expanded, programming languages have developed with them. Programming language allow the user to enter a control program into a PLC. The International Electrotechnical Commission (IEC 1131-3) standard defines three graphical languages and two text-based languages for use in PLC programming. The graphical languages use symbols to program control instructions, while the text-based languages use character strings to program instructions. The three graphical languages are ladder diagrams, functional block diagram and sequential function charts[4].

Ladder diagram is the most widely used programming language in industrial automation today. Its ease of use, traceability, and visual representation of physical components make it the favored programming method of many engineers. Ladder logic programming has been expanded to include functions such as counters, timers, shift registers and math operations.[5]

III. OPERATIONS AND SYSTEMATIC DESIGN PROCEDURES

Whatever the language in which a program is to be written, a systematic approach to the problem can improve the chance of high quality programs being generated in as short a time as possible. A systematic design technique is likely to involve the following steps:

1. A definition of what is required with the inputs and outputs specified.
2. A definition of the algorithm to be used. An algorithm is a step-by-step sequence which defines a method of solving the problem. This can often be shown by a flow chart or written in pseudocode.
3. An algorithm is then translated into instructions that can be inputted to the PLC.
4. The program is then tested and debugged.
5. The program is documented so that any person using or having to modify the program a later date understands how the program works. [4]

This paper describes the task of obtaining cyclic movement of three pistons in a cylinder. This might be to periodically push workpieces into position in a machine tool with another similar, but out of phase, arrangement being used to remove completed workpieces. Three pistons A, B and C that have to be actuated in the sequence: A to the left, A to the right, B to the left, B to

the right, C to the left and C to the right (A+, A-, B+, B-, C+, C-).

As a systematic designed procedure, the inputs and outputs are firstly defined. I:1/0 is the start switch. O:2/0, O:4/0, O:2/1, O:4/1, O:2/2 and O:4/2 are the outputs for piston A to the left, piston A to the right, piston B to the left, piston B to the right, piston C to the left and piston C to the right, respectively.

As a second step, algorithm to be used is defined. In this paper, flowchart is used as an algorithm. The flowchart of algorithm is shown in Figure 4.

Thirdly, flowchart of algorithm is then translated into instructions that can be inputted to the PLC. The instructions are written by ladder programming method. The ladder diagram for the three pistons movement in the sequence is shown in Figure 5.

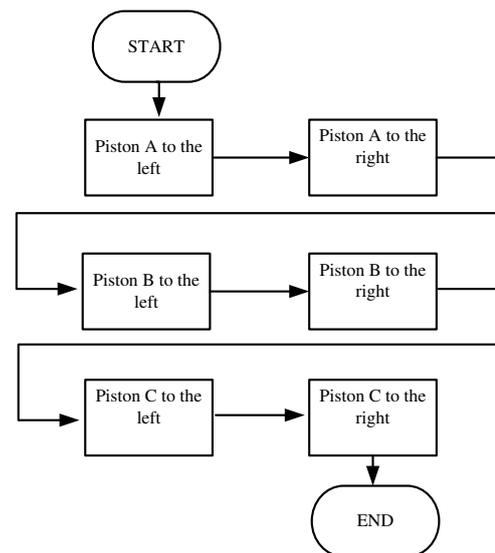


Figure 4. System Flowchart

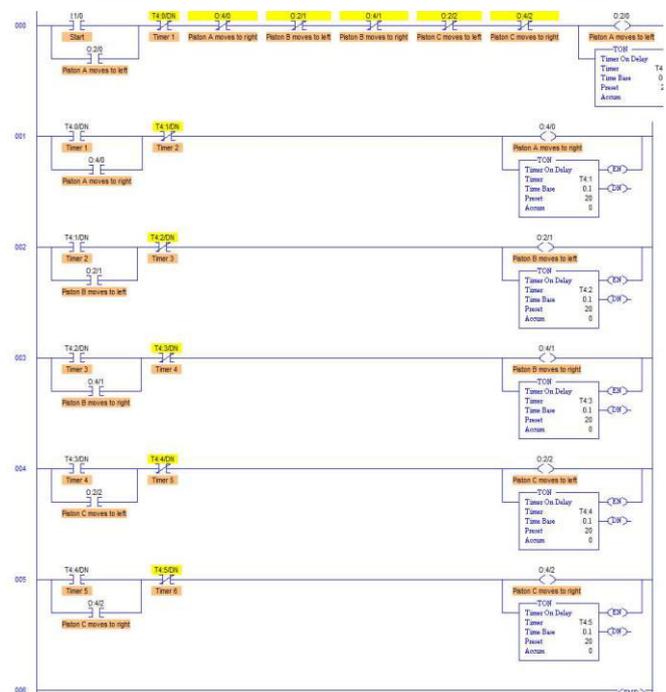


Figure 5. Ladder Diagram of the System

In the ladder diagram, when an input start switch I:1/0 is closed there is an output from O:2/0 and the timer T:4/0 starts. The start switch is latched by the output. Piston A moves to the left. After the present value =20 has reached, the normally closed timer T:4/0 contacts open and the normally open timer T:4/0 contacts close. This switches off O:2/0 and activates O:4/0 and starts timer T:4/1. Piston A moves to the right. The other rungs are operated the same procedures. Each succeeding rung activates the next solenoid. Thus in sequence, each of the outputs is energised.

After writing the complete program, it is saved, simulated and checked for errors, as the next step. Finally, the completed program is documented.

IV. SIMULATION RESULTS

The simulation result of the piston A moves to the left is shown in Figure 6. As a demonstration, O:2/0 light is switched on.

The simulation result of the piston A moves to the right is shown in Figure 7. As a demonstration, O:4/0 light is switched on.

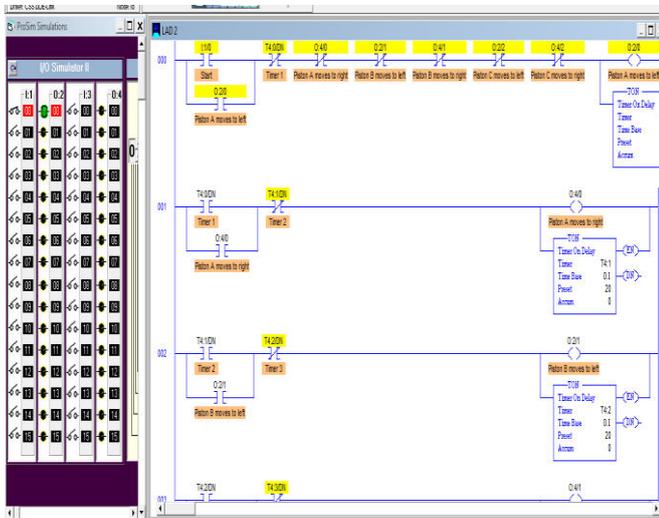


Figure 6. Simulation Result of Piston A to the Left

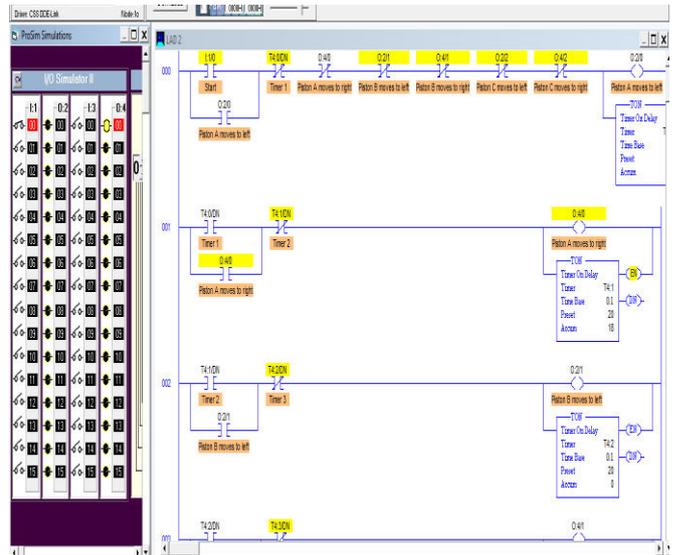


Figure 7. Simulation Result of Piston A to the Right

The simulation result of the piston B moves to the left is shown in Figure 8. As a demonstration, O:2/1 light is switched on.

The simulation result of the piston B moves to the right is shown in Figure 9. As a demonstration, O:4/1 light is switched on.

The simulation result of the piston C moves to the left is shown in Figure 10. As a demonstration, O:2/2 light is switched on.

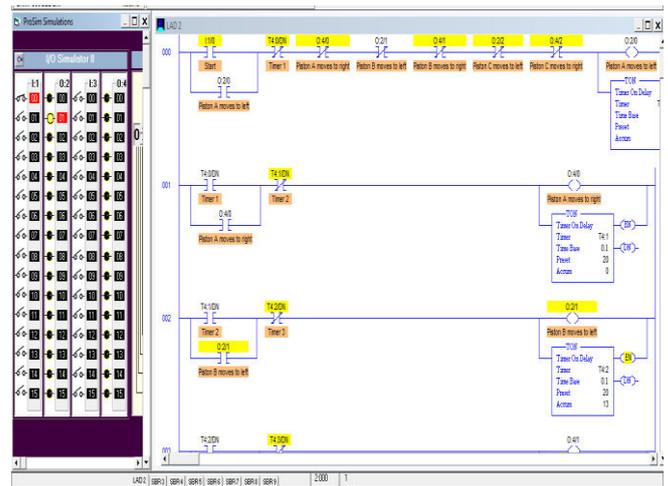


Figure 8. Simulation Result of Piston B to the Left

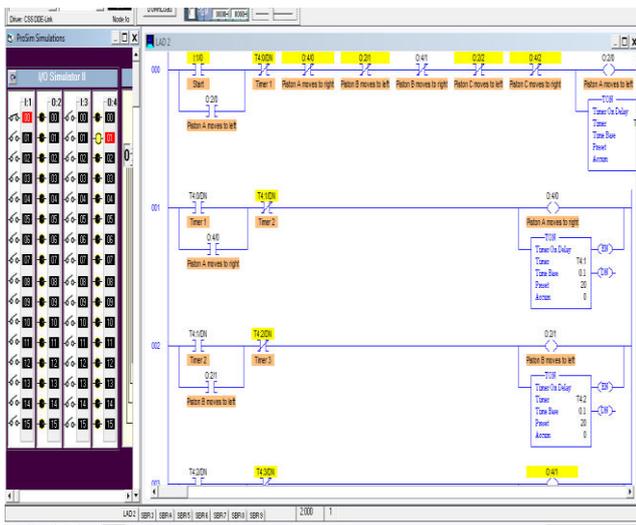


Figure 9. Simulation Result of Piston B to the Right

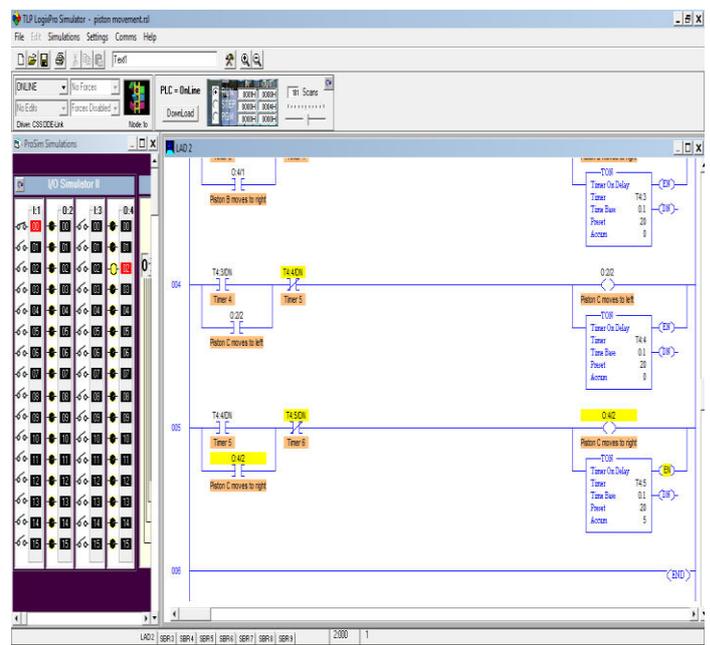


Figure 11. Simulation Result of Piston C to the Right

V. CONCLUSION

The systematic design procedures of PLC program for application of three pistons movement in sequencing is described. The ladder programming method is used as the programming language.

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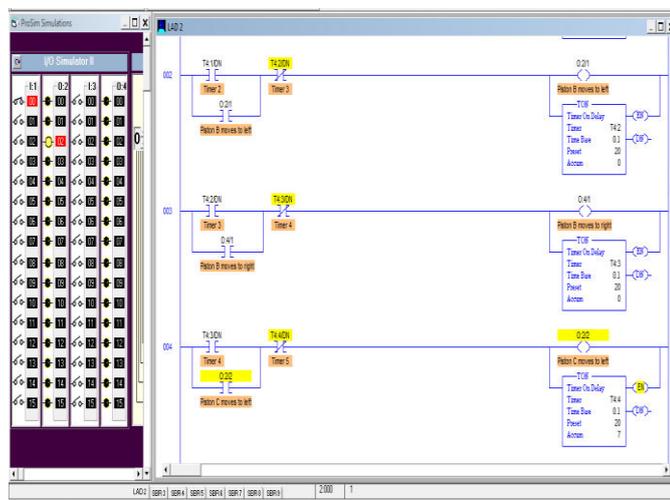


Figure 10. Simulation Result of Piston C to the Left

The simulation result of the piston C moves to the right is shown in Figure 11. As a demonstration, O:4/2 light is switched on.