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A Report on PLC Ladder Programming

Introduction

This report is about how to design a PLC ladder diagram to solve different automation problems using Siemens Logo!.

Task 1 SR flip-flop

The aim of task 1 is to design a Set-Reset(SR) flip-flop.

The circuit diagram of SR flip-flop is showed in Figure 1.1.

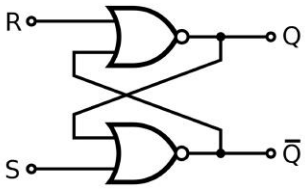

Figure 1.1 Circuit diagram of SR flip-flop

The logic equation can be easily derived as

$$Q = \overline{R + \overline{Q}}$$
$$\overline{Q} = \overline{S + Q}$$

According to the De Morgan theory,

$$Q = \overline{R + \overline{Q}} = \overline{R + \overline{S + Q}} = \overline{R} \cdot \overline{\overline{S + Q}} = \overline{R}S + \overline{R}Q$$

Thus the ladder diagram is designed as below.

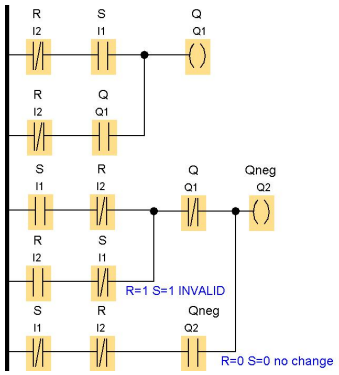

Figure 1.2 Ladder diagram of SR flip-flop

If the S button is pressed once, the first line is connected. Thus, the Q is activated. The second line acts as a latching. If the R button is pressed once, the first two lines are disconnected. Thus, the Q is reset to zero.

If both button are pressed, the output of Q and Qneg are all zeros, which means invalid. If either button is pressed, the third and fourth line is used to output the not Q,denoted by Qneg.

If the S and R are both unpressed, the Q and Qneg stays unchanged as its previous state.

Task 2 Traffic Light

The aim of task 2 is to design a PLC ladder program to perform the light sequence.

2.1 The Ladder Diagram

My basic idea of this program is to design a general block to realise the desired process in one single time range. Then copy five pieces of this block and change the input and output. It is straightforward but a little lengthy.

I divide the whole program into 2 parts as figure 2.1 shows. The first part is to light the traffic lights using the flags in part 2. In the second part, the program can be divided to 6 sub-parts, the first one is the trigger, the next 5 sub-parts output the flags for every time range.

Part 1 Light

Part 2
- 2.1 Trigger
- 2.2 LOOP{
  - T1 (OUTPUT Flag 1, DELAY 14s, GOTO T2)
  - T2 (OUTPUT Flag 2, DELAY 2s, GOTO T3)
  - T3 (OUTPUT Flag 3, DELAY 15s, GOTO T4)
  - T4 (OUTPUT Flag 4, DELAY 2s , GOTO T5)
  - T5 (OUTPUT Flag 5, DELAY 1s, GOTO T1)
  - }

Figure 2.1 The structure of task 2 (pseudo code in Fortran style)

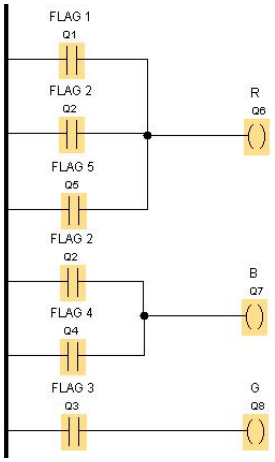

Figure 2.2 Part 1 of the ladder diagram for task 2

In part 2.1, a multiple function switch is used to realise the function of trigger. Every time you press the trigger, the state of T011 change from zero to one/ one to zero. A master switch is used in each of this 6 blocks to stop the program instantly.

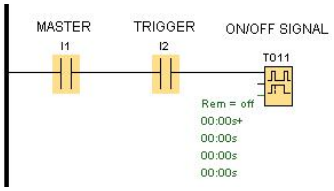

Figure 2.3 Part 2.1 of the ladder diagram for task 2

In part 2.2, taking time range 1 for example. An output ‘‘FLAG 1’’ is used to stands for the index of time range. A RS block is used for set and reset the flag. The ‘‘TIME 5 DELAY’’ block enables the loop of this program.

For this starting process particularly, if the trigger is pressed which means the start of this program. If TIME 5 DELAY is activated, which means the loop proceed into this time range, the set pin is activated.

Those three inputs for the reset pin are the conditions when the master switch is turned off, or the trigger is pressed again,or the process moves into the next time range. When the flag is activated, a time delay block is used to count down for lasting time and pass the signal to next stage.

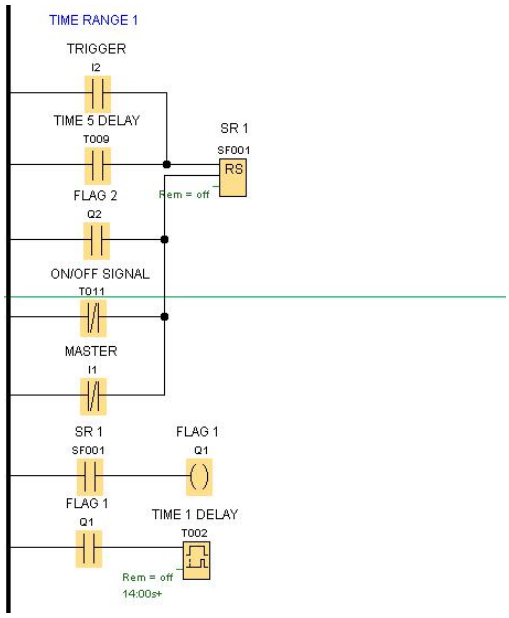

Figure 2.4 Part 2.2-1 of the ladder diagram for task 2

2.2 Simulation Results

When the master switch is turned on and the trigger is pressed once, the traffic sequence starts. It repeats until the trigger is pressed again or the master switch is turned off.

Task 3 The warehouse door

The aim of task 3 is to design a PLC ladder program to realise the automation of warehouse door.

3.1 The Ladder Diagram

My ladder diagram can be divided into 4 parts.

Part1: The light will be turned on as long as the motor starts to rotates.

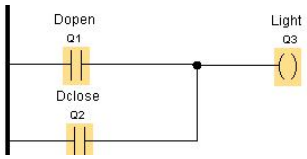

Figure 3.1 Part 1 of the ladder diagram for task 3

Part 2: The S_max is the sensor to detect if the door reach its largest height. If so, it should returns one. If the door is not fully open or closed, whenever the S_IR sensor detects there is something under the door, it should starts to open. If the door is not fully open, if the RC controller is pressed, the door should starts to open. The third line is used as latching. If the door is fully open, the motor should stop.

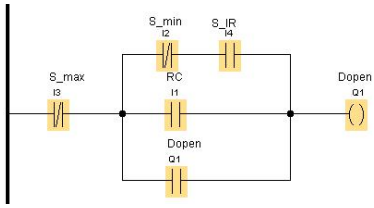

Figure 3.2 Part 2 of the ladder diagram for task 3

Part 3: Only if there is nothing under the door and the door is fully open, the timer should starts to count down for 15 seconds.

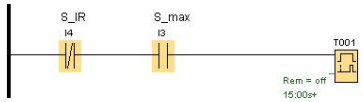

Figure 3.3 Part 3 of the ladder diagram for task 3

Part 4:The first Dopen block is used to make sure the rotor will always rotate in one direction. If the door is not fully closed and the RC button is not pressed, after the previous time delay, the door should starts to close. If the door is fully closed or RC button is pressed, the motor should stop.

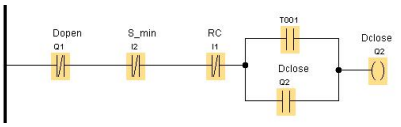

Figure 3.4 Part 4 of the ladder diagram for task 3

3.2 Simulation Results

Initial states are shown as table 3.1 below.

RC	S_min	S_max	S_IR	Dopen	Dclose	Light
0	1	0	0	0	0	0

Table 3.1 Initial states

Step 1, push the RC button, the Q1 and Q3 are turned on, which means the door is open while the light is on.

	RC	S_min	S_max	S_IR	Dopen	Dclose	Light
Step 1	1to 0	0	0	No effect	1	0	1
Step 2	0	0	1	No effect	0	0	0

Table 3.2 Open process

Step 2,when the S_max sensor is activated, the I3 will close. If the I4 sensor is not activated, which means there are nothing passing the door, the T001 starts to count down for 15 seconds. Otherwise, the T001 will wait until the sensor is deactivated.

	S_IR	S_max	T001
Situation 1	0	1	1
Situation 2	1	1	0

Table 3.3 Timer

Step 3, If the RC button is not pressed and S_IR sensor is not activated, the door will start to close while the light is on, and the S_max sensor should return to zero. Thus, the Q1 is reset to zero. When the S_min sensor is activated, the I2 will open. Thus, the motor stop rotating and the light is off. The program returns to the starting state.

If the RC button is pressed or the S_IR sensor is activated, the close process is break while the program should return to the previous open process.

		S_min	S_max	Dopen	Dclose	Light
RC=0 S_IR=0	Step 1	0	1 to 0	1	0	1
	Step 2	0	0	1	0	1
	Step 3	1	0	0	0	0
S_IR=1 or RC=1		0	0	1	0	1

Table 3.4 Closing process