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The Programmable Logic Controller Kit for Test Devices about Automation System

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Abstract

Now, Programmable Logic Controller (PLC) kit is developed based on the previous PLC kit. And their function of the demand for actual use is limited such as input and output, so they cannot be brought to test devices before installation. Thus, it resulted in a waste of time of installation without the kit for testing devices before installation.

This research needs to develop the PLC kit with touchscreen which is different from the previous version of PLC kit. The input and output is software from GT Designer2 program instead of hardware. And testing devices through the kit by using program, it can be applied with PLC electrical system about industrial automation system. This research experiment test device is called “interface board”. This PLC kit with touchscreen can be applied with real devices such as interface board by entering the input as BCD.

In addition, the PLC kit works similarly to the electrical control system as the automation system in industry. This PLC kit can bring to the real practice for increasing skills in working on automation system.

Keywords: PLC kit with Touchscreen, Apply, Testing devices

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INTRODUCTION

The developments of PLC kit for apply with real devices that important for the progression of the company. It is like the assistance tool for test devices before installation. For the purpose of reduce time consumption and installation problems. Moreover it can minimize the impacts of manufacturing in industry.

Therefore, the requirement to best uses this PLC kit with touchscreen that be similar to the existing real system which available in the industry as the most. And it should have the basics first for can be applied to real devices in the industry.

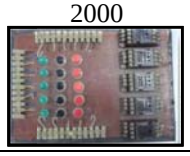
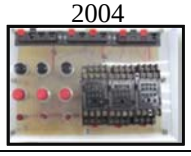
The previous research study

Programmable Logic Controller (PLC) kit for teaching and learning is developed based on the existing PLC trainer that is not able to achieve the objective and learning outcome in enhancing the hands on skill aspect through circuit designing, installation and trouble shooting. The existing PLC trainer board comes with a casing where students have the difficulty in observing and understanding the connection between the input module, PLC controller and output modules. The development of PLC kit has been designed and improved by increasing the number of input and output components, cost reduction and it is also user friendly. This PLC kit is embedded with I/O module such as normally open push buttons, 24VDC motor, 24VDC relay, 24VDC solenoid cylinder and 24VDC lamp. This PLC Kit can be interfaced to various types of PLC controller such as Omron, Siemens and Panasonic (NAIS). Based on students Lab Practical Assessment record, it is found that there is 39% improvement of knowledge and hands on skill when students use the PLC kit. Learning PLC-programming is best by practicing with real devices. In 1997, the only readymade device that was prepared for teaching and learning is shown in Figure 1. (This device uses keypad for entering data.) [1]

Figure 1: PLC-NAIS FP1-C24 [1]

From Figure 1 be seen device don't shows Input and Output function that it is a limitation of obsolete PLC models, but it can use practicing and learning. Later, it was developed into other models and appropriate to the times as in Table 1.

Table 1: Previous Polytechnic PLCs for application [1]

Version	Previous Polytechnic PLC kit	Problem Finding
01	2000 	Complex connection and takes longer time for practice. Loose terminal screw due to wear and tear. Difficult for troubleshooting due the structure made from wood.
02	2004 	Problems with the plug in terminal. Cable terminal always break due to regular application. Output module shown through relay and lamp only.
03	2007 	Using male and female connector wire (banana jack). Only lamp as the output module.
04	2011 	Structure from plastic casing. Various output components such as motor, solenoid cylinder, relay and lamp. Need to connect PLC to I/O module.
05	2012 	Wiring is in a mess as difficult to troubleshoot.

In Table 1 shown Polytechnic PLC kit from the past to the present that not enough skills for apply with real work.

Problems and motivation

The PLC kit of previous research also inappropriate to the assistance tool for test devices. It causes problems in the installation because no test devices before install. It affects the industry such as to take a long time to install the device, waste time programming to make devices work and affect the production.

This research needs to build the kit and it consists of PLC kit and Touchscreen. The testing of this PLC kit with touchscreen is measured with real devices before installation.

Objectives of Research

1. To develop PLC and touchscreen kit for applications
2. To design program from this kit for transfer program to use in real working

Scope of research study

1. Designing program with Interface board only.
2. Only test output in ladder diagram with operation of the kit.
3. This research is suitable for industry used PLC of Mitsubishi brand.

Steps of research study

1. Study and research information for develop kit.
2. Design and building the PLC kit with touchscreen.
3. Search and prepare real device for test with the kit.
4. Design tested programming.
5. Usability testing and record the results.

6. Report conclusion the results of research study.

Research study plan

Months	Nov-13				Dec-13				Jan-14				Feb-14				Mar-14				Apr-14				May-14				Jun-14				Jul-14				Aug-14			
Steps / Weeks	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1. Study and data collection	▨	▨	▨	▨	▨																																			
2. Design and building the PLC Kit with Touchscreen					▨	▨	▨	▨	▨	▨	▨	▨																												
3. Search and prepare real device for test with the Kit													▨	▨																										
4. Design tested programming															▨	▨	▨	▨	▨	▨	▨	▨	▨	▨																
5. Usability testing and record the results.																									▨	▨	▨	▨	▨	▨	▨									
6. Report conclusion the results of research study																															▨	▨	▨	▨	▨	▨	▨	▨	▨	▨

Expect Contribution

1. This PLC kit with Touchscreen can be the assistance tool for test real devices before install.
2. This PLC kit with Touchscreen can be used to practice programming for those who want to learn.
3. This PLC kit with Touchscreen can be applied for PLC learning classes and learners can design and simulate the virtual operation.

THEORY SUPPORT

1. Principle of PLC[3]

As mentioned in the PLC, the central processing unit, or CPU, is the most important element of a PLC. The CPU forms what can be considered to be the “brain” of the system. The three components of the CPU are:

- The processor
- The memory system
- The power supply.

2. BINARY NUMBER SYSTEM[3]

The *binary number system* uses the number 2 as the base. Thus, the only allowable digits are 0 and 1; there are no 2s, 3s, etc. For devices such as programmable controllers and digital computers, the binary system is the most useful. It was adopted for convenience, since it is easier to design machines that distinguish between only two entities, or numbers (i.e., 0 and 1), rather than ten, as in decimal. Most physical elements have only two states: a light bulb is on or off, a valve is open or closed, a switch is on or off, and so on. In fact, you see this number system every time you use a computer—if you want to turn it on, you flip the switch to the 1 position; if you want to turn it off, and you flip the switch to the 0 position. Digital circuits can distinguish between two voltage levels (e.g., +5 V and 0 V), which makes the binary system very useful for digital applications.

As with the decimal system, expressing binary numbers greater than the largest-valued symbol (in this case 1) is accomplished by assigning a weighted value to each position from right to left. The weighted value (decimal equivalent) of a binary number is computed the same way as it is for a decimal number—only instead of being 10 raised to the power of the position, it is 2 raised to the power of the position. For binary, then, the weighted values from right to left are 1, 2, 4, 8, 16, 32, 64,

etc., representing positions 0, 1, 2, 3, 4, 5, 6, etc. Let's calculate the decimal value that is equivalent to the value of the binary number 10110110:

Thus, the binary number 10110110 is equivalent to the number 182 in the decimal system. Each digit of a binary number is known as a **bit**; hence, this particular binary number, 10110110 (182 decimal), has 8 bits. A group of 4 bits is known as a **nibble**; a group of 8 bits is a **byte**; and a group of one or more bytes is a **word**. presents a binary number composed of 16 bits, with the **least significant bit (LSB)**, the lowest valued bit in the word, and the **most significant bit (MSB)**, the largest valued bit in the word, identified.

METHOD OF OPERATION

1. Preparation for building the PLC kit

1.1 Base unit Model Q312B
1.2 GOT1000 model GT1575-VNBA
1.3 Cable GT15-QC30B link between PLC and Touchscreen
1.4 Power supply model Q61P
1.5 CPU unit model Q02HCPU
1.6 Output module model QY50
1.7 Mistubishi breaker 5A model NF30-CS
1.8 Power supply 24VDC
1.9 Structure of PLC kit and touchscreen
1.10 Software GT Designer 2[5]
1.11 Software PLC GX Developer[4][2]

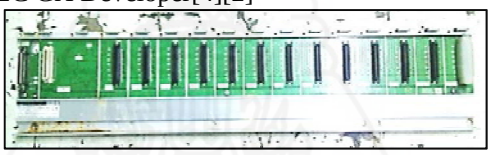


Figure 2: Base unit Model Q312B

Figure 3: GOT1000 model GT1575-VNBA

Figure 4: Cable GT15-QC30B link between PLC and Touchscreen

Figure 5: Power supply model Q61P
CPU unit model Q02HCPU
Output module model QY50

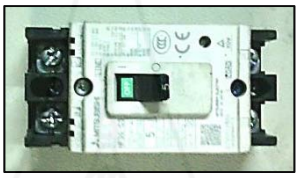


Figure 6: Mistubishi breaker 5A model NF30-CS

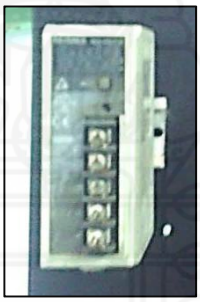


Figure 7: Power supply 24VDC

Figure 8: Structure of PLC kit and touchscreen

2. Building the PLCs Kit

After prepare devices of the Kit. To bring them to build the PLC Kit with Touchscreen as follows:

Figure 9: STEP 1

STEP 1: Bring Touchscreen GOT1000 model GT1575-VNBA to mount with structure by using four bolts behind it.

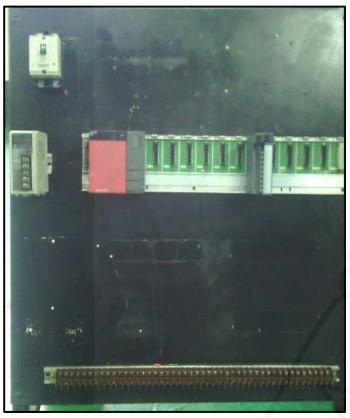


Figure 10: STEP 2

STEP 2: Bring devices: Mitsubishi breaker 5A model NF30-CS, Power supply 24VDC, Base unit Model Q312B, Power supply model Q61P, CPU unit model Q02HCPU, and Output module model QY50 to install on structure as Figure 10

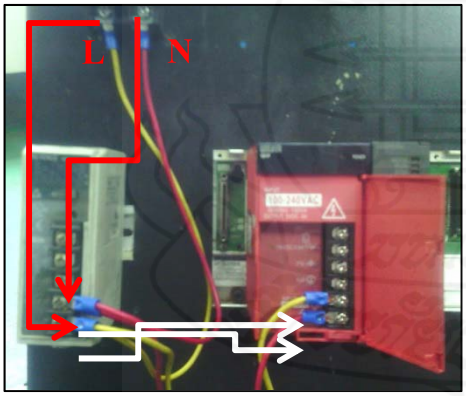
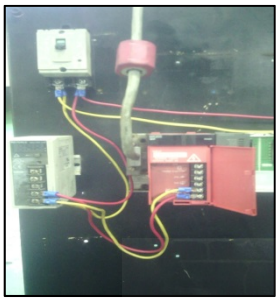


Figure 11: STEP 3

STEP 3: To wire the control of Mitsubishi breaker 5A Model NF30-CS, which will supply power 220 VAC to the Power supply 24VDC and Power supply model Q61P as Figure 11


(A)

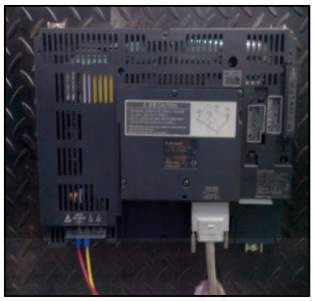

(B)

Figure 12: STEP 4

STEP 4: From Figure 12A, To wire the control Mitsubishi breaker 5A model NF30- CS, which will supply 220 VAC and GT15-QC30B cable into the back of Touchscreen GOT1000 model GT1575-VNBA as Figure 12B

Figure 13: STEP 5

STEP 5: Arrange the wires to appropriate and suitable for use as Figure 13

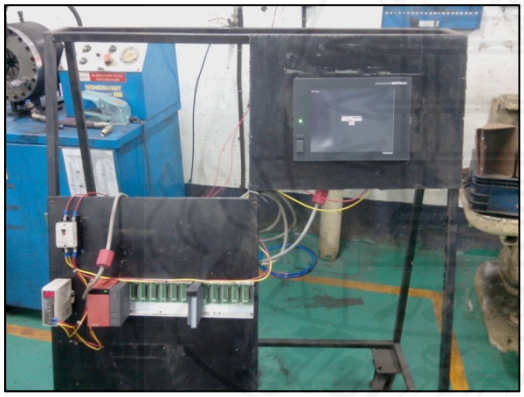


Figure 14: STEP 6

STEP 6: Completed set of the PLC Kit with Touchscreen

EXPERIMENT

This PLC kit with Touchscreen was tested with real devices and machine that used in one industrial factory. This Project was created by me, it has high possibility. However, the equipment to build this kit has characteristics and not sold in general market, it must be specially made for consistency with the PLC module was used.

1. Operations of PLC kit with Touchscreen

From Figure 15 is operation of PLC kit with Touchscreen was used on one machine that it has the loop feature. This machine can be used with several models of product. Operation of each models enter the numeric input that it is number of product's model or part number, and it depends on

the user enter a command. Additional installation device, it is device for show product's model or part number when the machine is running. There are steps for testing as Figure 16

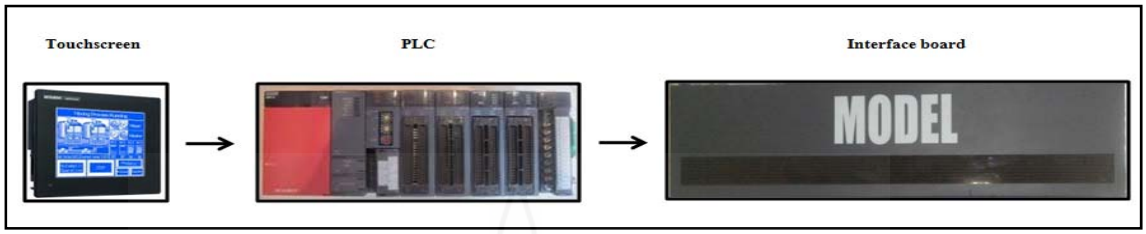


Figure 15: Diagram of this project

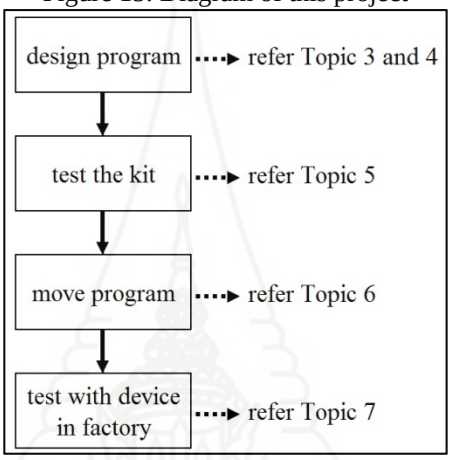


Figure 16: Steps of testing

2. Checking the details of part numbers

From Table 2 is checking the details of part number can do on touchscreen, it has details of each model's part number. Each part number have the different parameters, it depends on size of products.

Table 2: Parts number and product's model

No.	Description	Diameter (mm.)	Number Coiling 1
1	MMTH A-FR	13.6	345
2	MMTH B-FR	10.3	381
3	MMTH 25-FR	10.2	380
4	MMTH D-FR	10.0	379
5	MMTH 26-FR	10.2	465

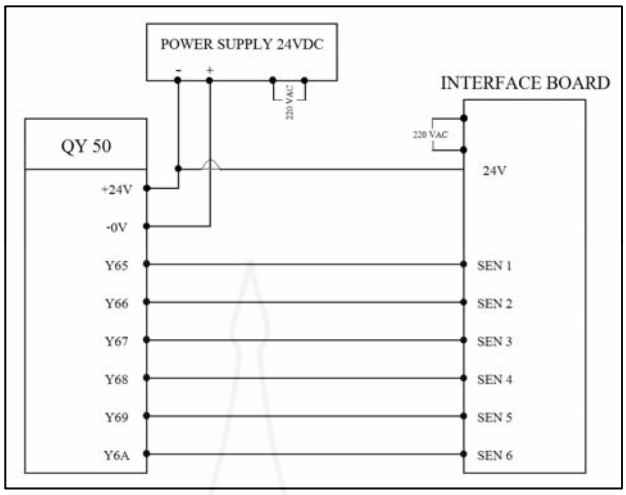


Figure 17: Wiring diagram for test device

From Figure 17 is wiring diagram for testing device, this diagram used for test with the kit was built and interface board.

3. Design Ladder Program of PLC

First, Ladder PLC programming used BCD number writing technique before, it is the arrangement of part number from the beginning to the end as in Table 3.

Table 3: Shows Output by BCD method

No.	Program No.	Y6A	Y69	Y68	Y67	Y66	Y65
1	345	0	0	0	0	0	1
2	381	0	0	0	0	1	0
3	380	0	0	0	0	1	1
4	379	0	0	0	1	0	0
5	465	0	0	0	1	0	1

From Table 3 show amount of data in each output. Output column; Y65, Y66, Y67, Y68 and Y6A.

4. Design touchscreen by GT Designer 2

Design Touchscreen as Figure 18, design to use for test PLC program. Touchscreen is responsible for enter input, that type is numeric input. And output is shown 1 that has 6 outputs such as Y65, Y66, Y67, Y68, Y69 and Y6A. Status of operation, when output on its status will show in orange and off will show in black.

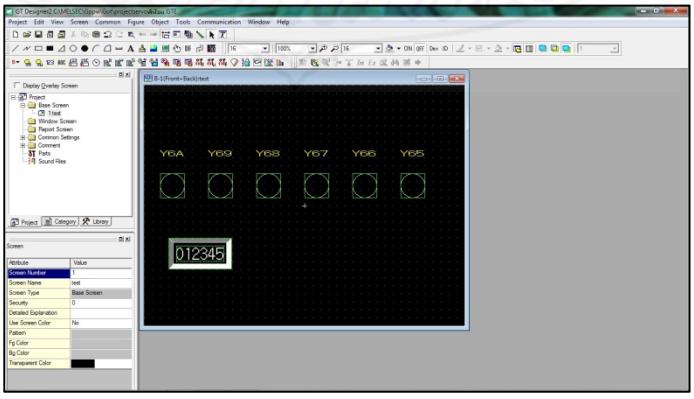


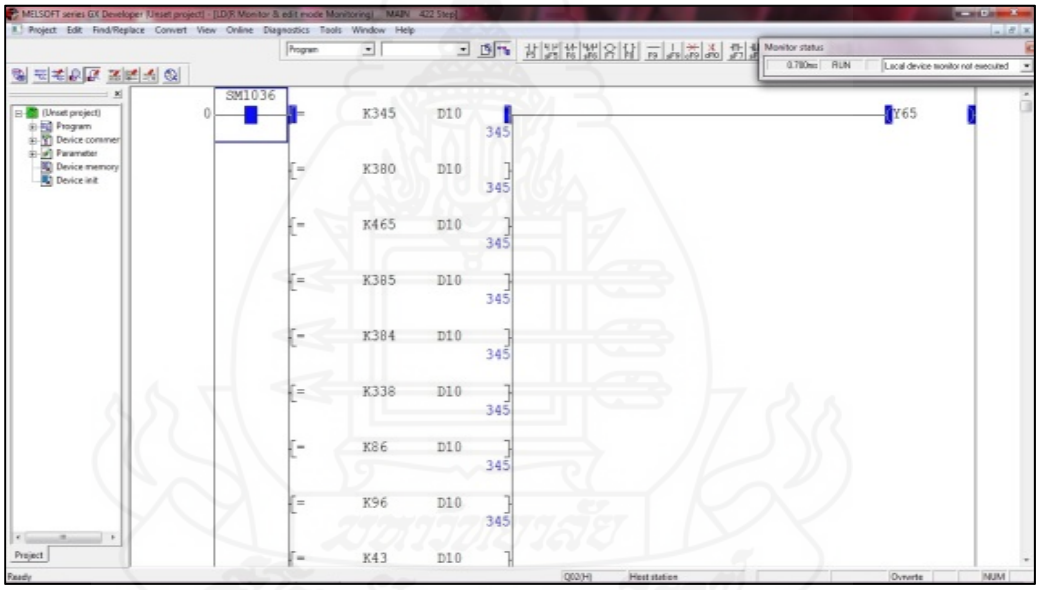
Figure 18: Design touchscreen by GT Designer 2

5. Checking program and kit

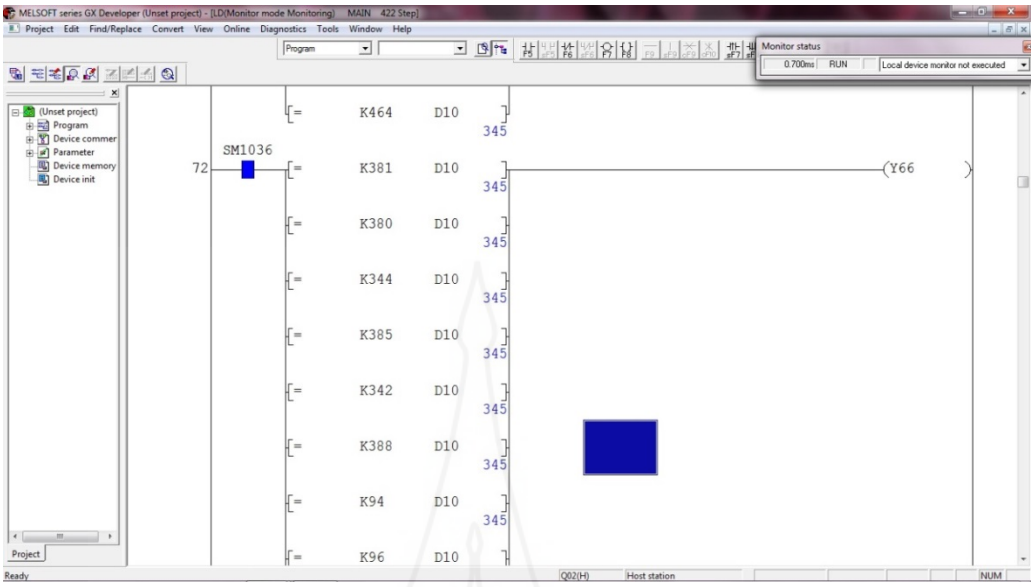
Checking program test by refer from Table 3. This test is to enter Input through touchscreen, enter program number as Table 3. Thus, output will show as Table 3 too, if Output on = 1 that is orange, and Output off = 0 is black. For example to checking program as in Figure 19.

Figure 19: Checking program no. 345

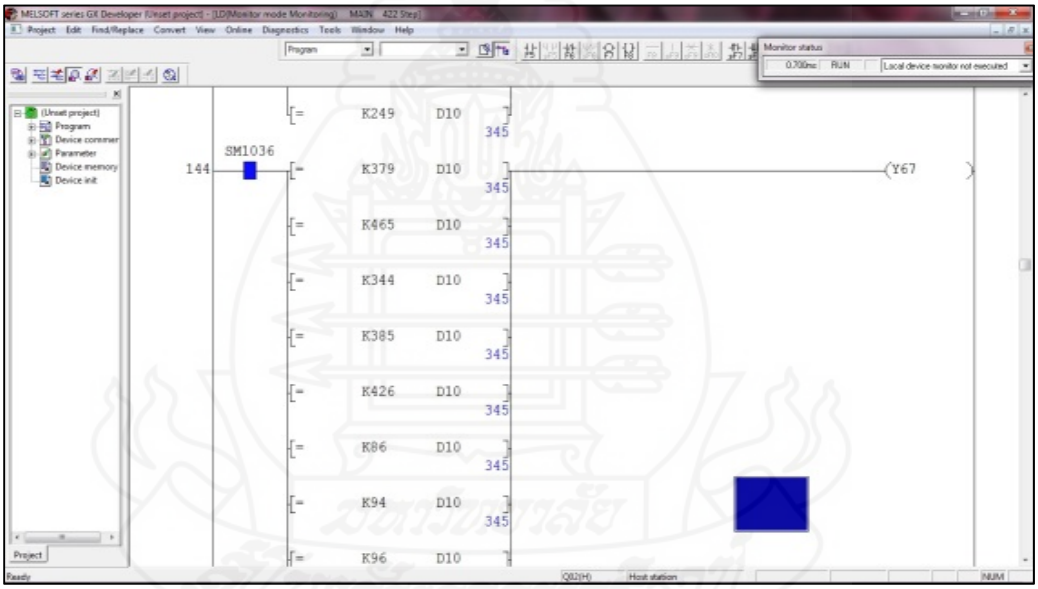
From checking program in Figure 19 and next checking operation of program is accuracy.



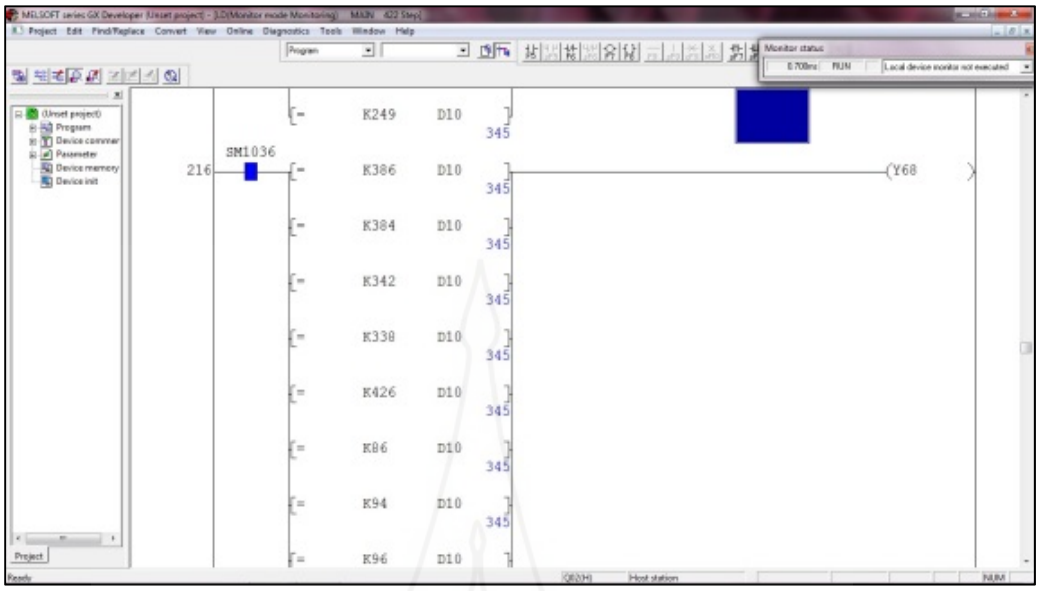
(A)


MELSOFT series GX Developer (Unset project) - [LD(Monitor mode Monitoring) MAIN 422 Step]
Project Edit Find/Replace Convert View Online Diagnostics Tools Window Help
Monitor status
SM1036
72
K464 D10 345
K381 D10 345
Y66
K380 D10 345
K344 D10 345
K385 D10 345
K342 D10 345
K388 D10 345
K94 D10 345
K96 D10
Ready
Host station

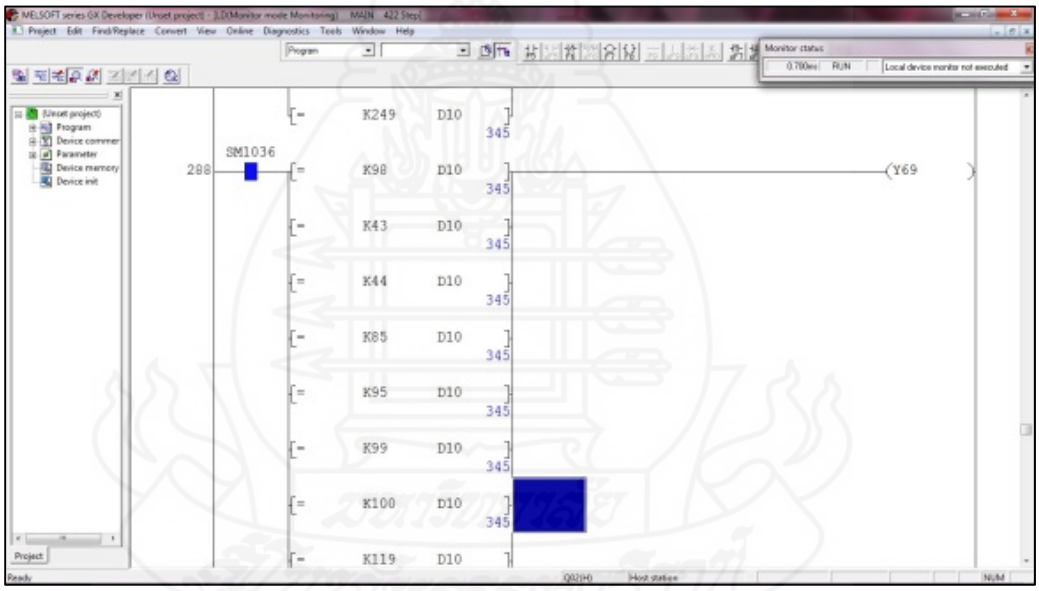
(B)


SM1036
144
K249 D10 345
K379 D10 345
Y67
K465 D10 345
K344 D10 345
K385 D10 345
K426 D10 345
K86 D10 345
K94 D10 345
K96 D10

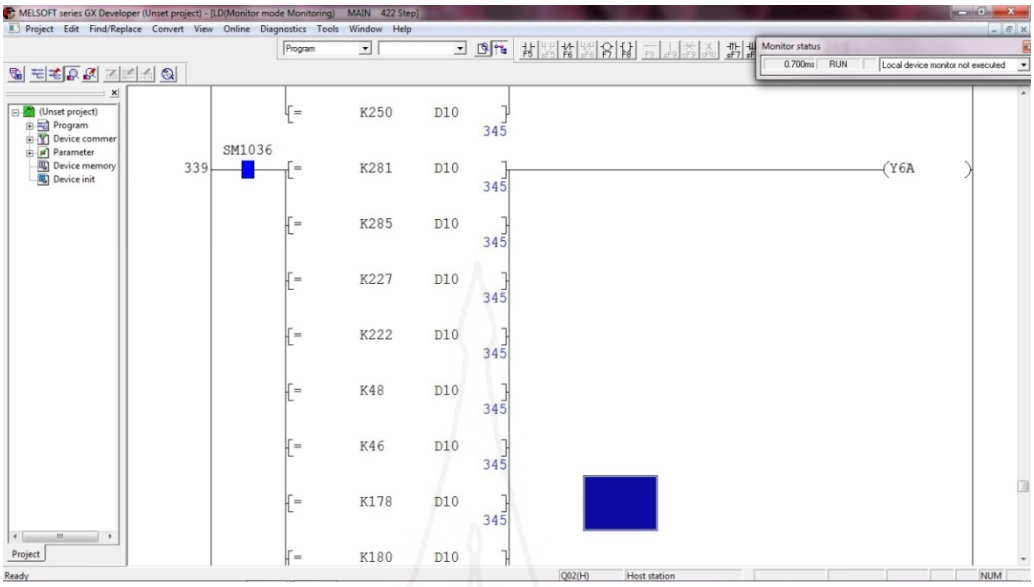
(C)


SM1036
216
K249 D10
K386 D10
K384 D10
K342 D10
K338 D10
K426 D10
K86 D10
K94 D10
K96 D10
345
Y68

(D)


SM1036
288
K249 D10
K98 D10
K43 D10
K44 D10
K85 D10
K95 D10
K99 D10
K100 D10
K119 D10
345
Y69

(E)

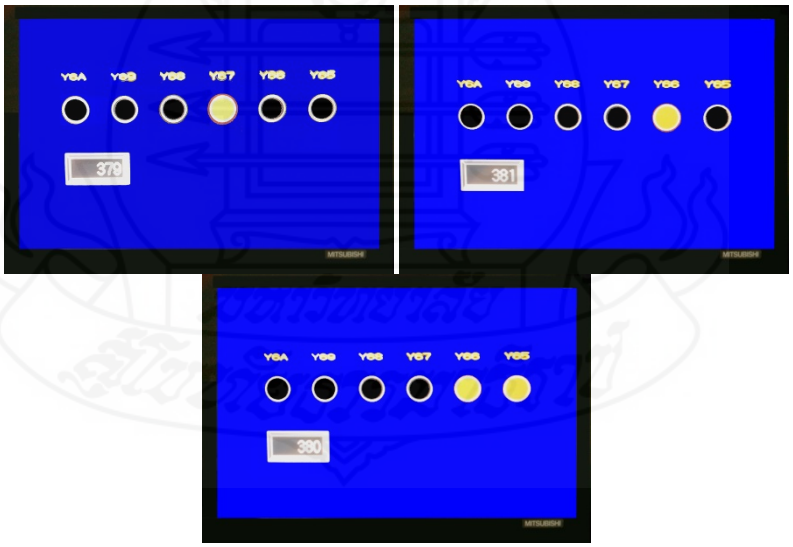


(F)

Figure 20: Checking operation of program

From checking as above found that enter Input is 345, Output is Y65 operate as figure 20(A). Output don't operate is Y66, Y67, Y68, Y69 and Y6A as figure 20 (B)(C)(D)(E)(F), and transform to BCD is 000001. Therefore this result compare with Table 3 is correctly.

Total checking by enter all data as Table 3, for check the accuracy of program before bring it to apply with real device as Figure 21. From this checking accord to Table 3 is designed.



(A) (B) (C)

Figure 21: Output according to Table 3

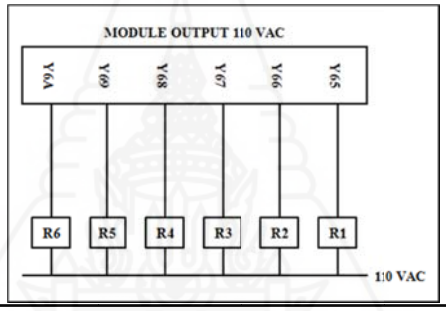
6. Real application with device of automation system

Add wiring circuit as Figure 22 for bring program and tested devices to installation. For prove program writing and the kit, they can apply really.

(A) (B) (C)

Figure 22: Installation of additional devices

From Figure 22 can diagram wiring circuit according to Figure 23 and 24.



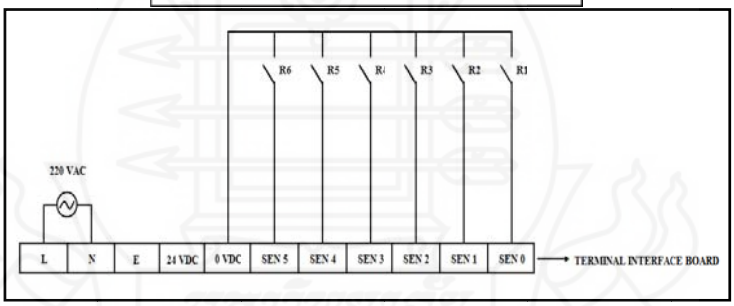


Figure 23: Circuit wiring of Output module Figure 24: Circuit wiring of Interface board

Then, upload program PLC of machine and open together with designed program, for copy by cut and paste. In addition, the advantage of cut and paste is reduce waste time by copy program from the tested kit and paste on PLC electrical system in factory.

7. The overall view testing

The overall view testing be tested by enter Input on Touchscreen, and Output shows the results on Inter face board. Also the results compare with data in Table 3, it is correct or not.

Figure 25: Enter part number 380 on Touchscreen Figure 26: The result after enter part number 380

Figure 25 shown to enter part number on Touchscreen. (Enter part number 380) And Figure 26 show the result after enter part number 380, and bring it to check with Table 2 and Table 3. Results show that the model is correct.

Checking Ladder Program in PLC can be seen after enters Input 380 or D10 = 380, resulting Output Y65 as figure 27 and Y66 as figure 28 operate. And it compare with Table 3 BCD = 000011 which same from Table 3.

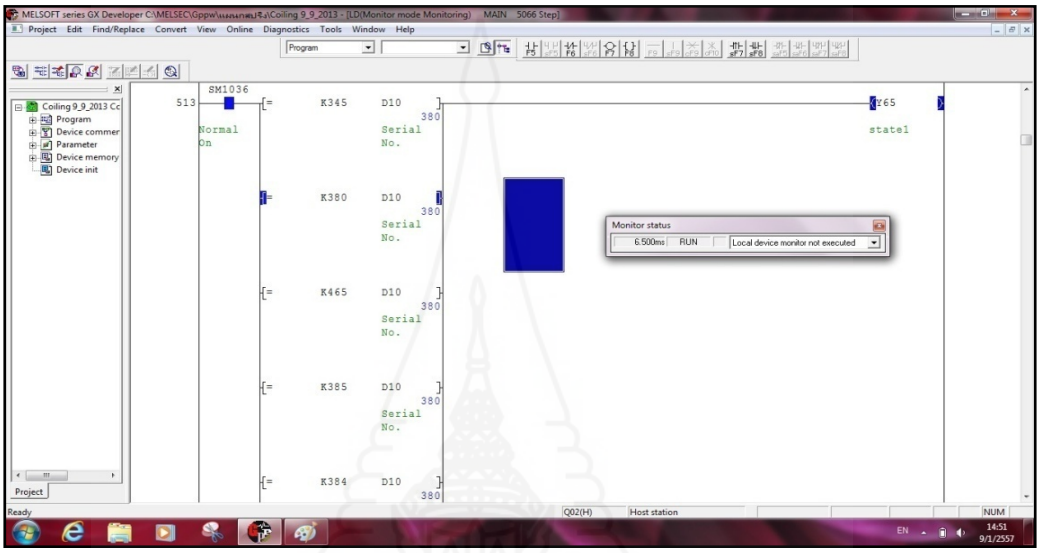


Figure 27: Ladder diagram shows Y65 operate

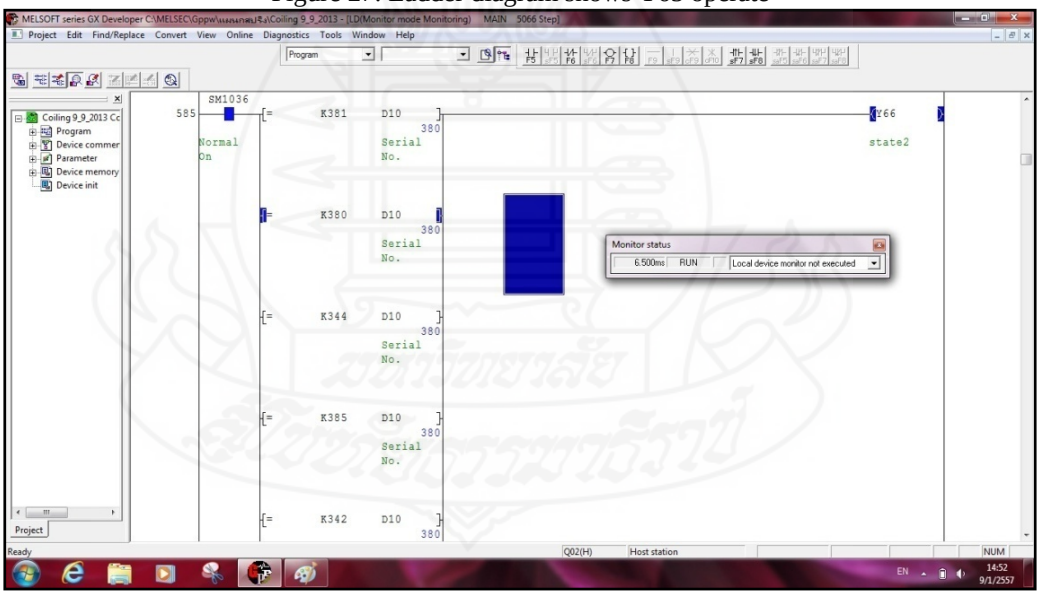


Figure 28: Ladder diagram shows Y66 operate

From testing the kit, it tested with data in Table 3 and designed ladder program for use in PLC. It can be resulted the kit can design program to apply with tested device. That device was tested by changing output from PLC to BCD and tested before installation, which designed output is correctly. After, devices were installed in area of industry and wiring circuit with devices, according to tested program with the kit by copy and paste program. This step can reduce waste time for writing program again.

CONCLUSION

Therefore the PLC kit was built for test devices as mentioned above. From experiment, it can be seen that the PLC kit can design circuit of PLC, and bring it to test program which is correctly as designed. Designed program can apply with real working and reduce waste time for design new program. In addition, the PLC kit works similarly to the electrical control system as the automation system in industry. This PLC kit can bring to the real practice for increasing skills in working on automation system.

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