CHAPTER 1 INTRODUCTION

The developments of a PLC kit are usually applied in many real devices that are important for the benefits of companies. A PLC kit is an assistance tool for preinstallation device testing in order to reduce time and installation problems. Both the PLC kit is easy to use and can be applied with several settings. Users can learn how to use the PLC kit by themselves by reading manuals available on various websites. Moreover the PLC kit can minimize the impacts of manufacturing in industry.

Therefore, basic skills of users are indeed necessary to meet requirements of this PLC kit. It is also equipped with a touchscreen similar to an existing real system available in the industry.

1.1 The previous research study

A 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 an 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 with various brands of PLC controllers such as Omron, Siemens and Panasonic. 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. PLC-programming is best learnt by practicing with real devices. In 1997, the only ready-made device that was prepared for teaching and learning is shown in Figure 1. (This device uses keypad for enter data.) [1]

Figure 1.1 PLC-NAIS FP1-C24[1]

As presented in Figure 1, the device did not display input and output function. It was regarded as a limitation of obsolete PLC models. However, it could be used for practicing and learning. Later, it was developed by modern technology to suit utilization as described in Table 1.1.

Table 1.1 Versions of Previous Polytechnic PLCs for application [1]

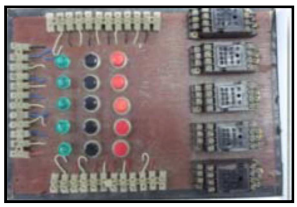
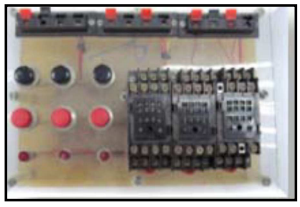
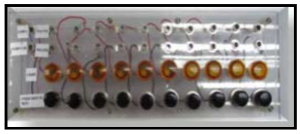
Version	**Figure of Previous Polytechnic PLC Kit (Year)**	**Problems**
01	2000 	Complex connection and taking longer time for practice. Loose terminal screw due to wear and tear. Difficult for troubleshooting due the wooden structure.
02	2004 	Problems with the plug in terminal. Cable terminal was always broken due to regular use. Output module was shown through a relay and a lamp only.
03	2007 	Using male and female connector wires (banana jack). Lights were only bright in the output module.

Table 1.1 Versions of Previous Polytechnic PLCs for application [1] (Continued)

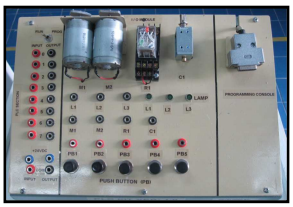
Version	Figure of Previous Polytechnic PLC Kit (Year)	Problems
04	2011 	Structure from plastic case. Various output components such as motor, solenoid cylinder, relay and lamp. Needed to connect the PLC to I/O module.
05	2012 	Wires were in a mess and it was difficult for troubleshooting.

Table 1.1 demonstrates several versions of Polytechnic PLC Kits which are suitable for real application.

1.2 Problems and motivation

The PLC Kit of previous research was inappropriate for testing devices and it caused some installation problems because no devices were tested before installing. Moreover, it took a long time to install programs to help devices work more efficiently which affected production as well.

Thus this research aimed to build the Kit consisting of PLC Kit and touchscreen. The PLC Kit was tested by applying with real devices before installation.

1.3 Objectives of Research

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

1.4 Scope of research study

1. Interface board was utilized to design program.
2. Only output in ladder diagram was tested by the kit.
3. The kit was suitable for the industry using PLC of Mitsubishi.

1.5 Steps of research study

1. Study and search for information to develop the kit.
2. Design and generate the PLC Kit with Touchscreen.
3. Seek and prepare real devices for testing with the Kit.
4. Design appropriate program.
5. Conduct testing and record results.
6. Report results and conclusion of research.

CHAPTER 2 THEORY SUPPORT

2.1 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

Figure 2.1 illustrates a simplified block diagram of a CPU. CPU architecture may differ from one manufacturer to another, but in general, most CPUs follow this typical three-component organization. Although this diagram shows the power supply inside the CPU block enclosure, the power supply may be a separate unit that is mounted next to the block enclosure containing the processor and memory. Figure 2.2 shows a CPU with a built-in power supply. The programming device, not regarded as part of the CPU, completes the total central architecture as the medium of communication between the programmer and the CPU.

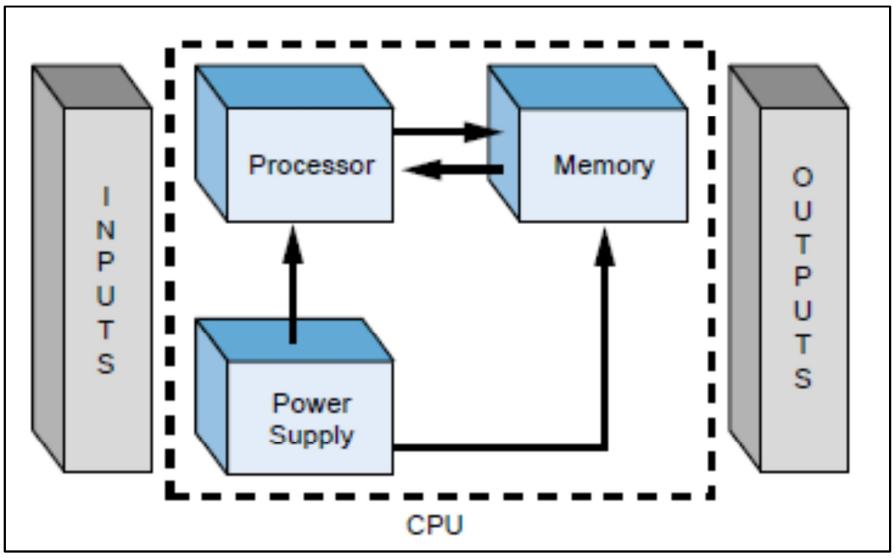


Figure 2.1 CPU block diagram

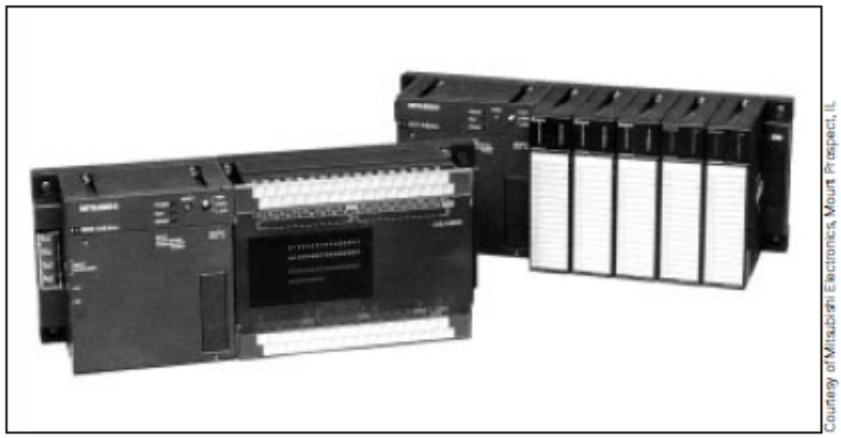


Figure 2.2 Two PLC CPUs with built-in power supplies (left with fixed I/O blocks and right with configurable I/O).

The term *CPU* is often used interchangeably with the word *processor*; however, the CPU encompasses all of the necessary elements that form the intelligence of the system—the processor plus the memory system and power supply. Integral relationships exist between the components of the CPU, resulting in constant interaction among them. Figure 2.3 illustrates the functional interaction between a PLC's basic components. In general, the processor executes the control program stored in the memory system in the form of ladder diagrams, while the system power supply provides all of the necessary voltage levels to ensure proper operation of the processor and memory components.

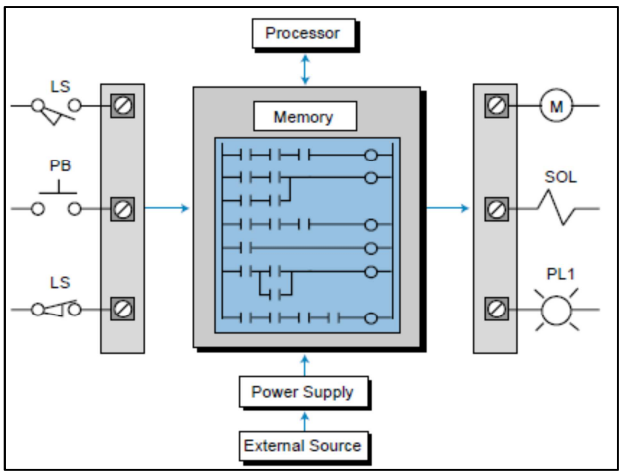


Figure 2.3 Functional interaction of a PLC system.

2.2 GT Designer 2 Screen Design Software [5]

In Figure 2.4, GT Designer is a screen design software program used to create HMI screens for the entire line of Mitsubishi Electric GOTs. A user-friendly Windows environment provides a simple and recognizable interface, facilitating a fast learning curve for new users.

GT Designer 2 is equipped with a parts library, a range of touch-switches and lamps, screen preview functionality, a GOT communication settings utility, and a project consistency check function. Together, these features combine to make GT Designer 2 a platform that produces screens that simplify the control interface between the user and the machine.

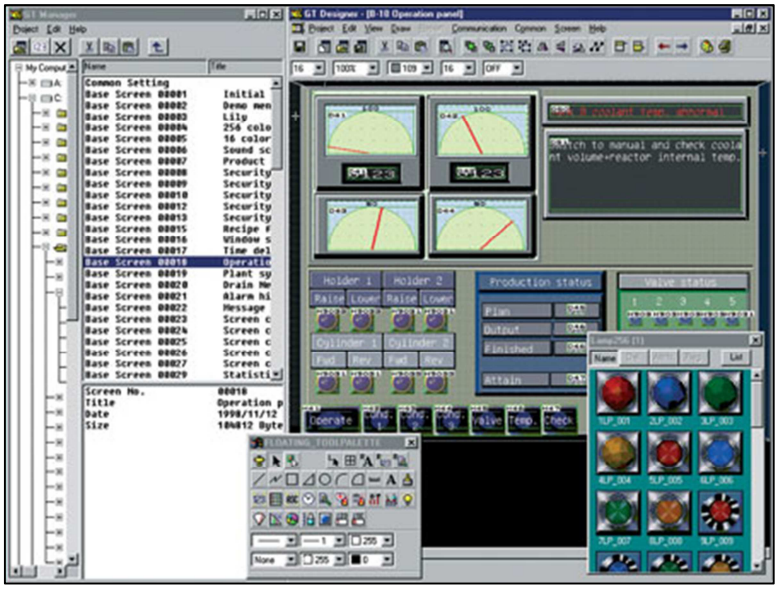


Figure 2.4 GT designer 2

2.3 GX Developer PLC Programming Software [4]

From Figure 2.5, GX Developer supports all MELSEC controllers from the compact PLCs of the MELSEC FX series[2] to the modular PLCs including MELSEC System Q. This software shines with a simple, intuitive interface and a short learning curve.

GX Developer supports the MELSEC instruction list (IL), MELSEC ladder diagram (LD) and MELSEC sequential function chart (SFC) languages. Moreover this program can switch back and forth between IL and LD at will while are working and can program function blocks (MELSEC QnA/QnAS/System Q series) by users. A wide

range of utilities are available for configuring special function modules for the MELSEC System Q. And "configure" is the operative word here - no longer need to program special function modules, and just configure them.

The package includes powerful editors and diagnostics functions for configuring MELSEC networks and hardware, and extensive testing and monitoring functions to help get applications up and running quickly and efficiently.

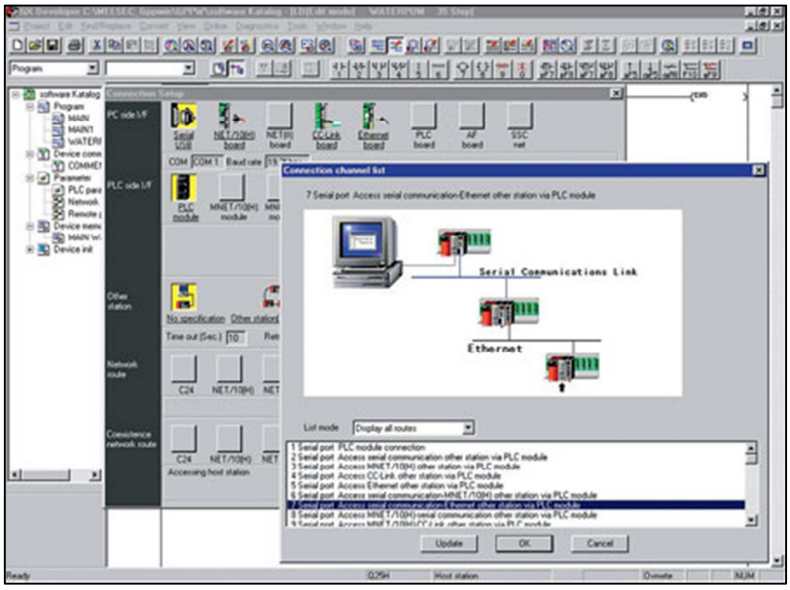


Figure 2.5 GX developer

2.4 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. That 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, can see this number system every time when use a computer—if want to turn it on, flip the switch to the 1 position; if want to turn off, and flip the switch to the 0 position (see Figure 2.6). 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.

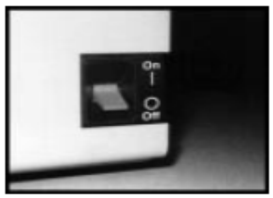


Figure 2.6 Turn off/on switch

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 that is for a decimal number—only instead of being 10 raised to the power of the position, That 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:

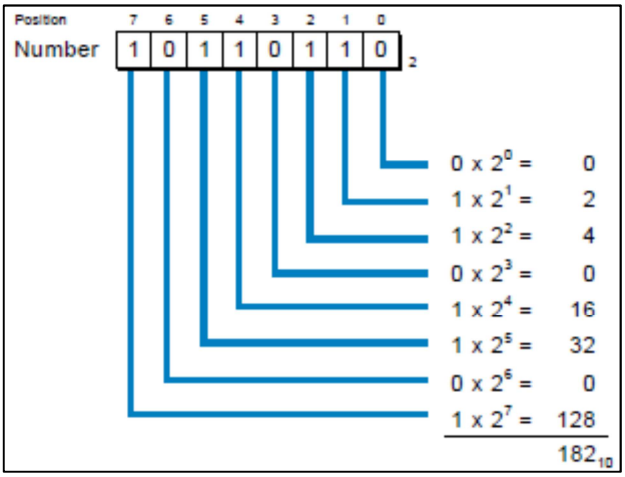


Figure 2.7 Position number

Thus, the binary number 10110110 is equivalent to the number 182 in the decimal system as Figure 2.7. 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. Figure 2.8 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.

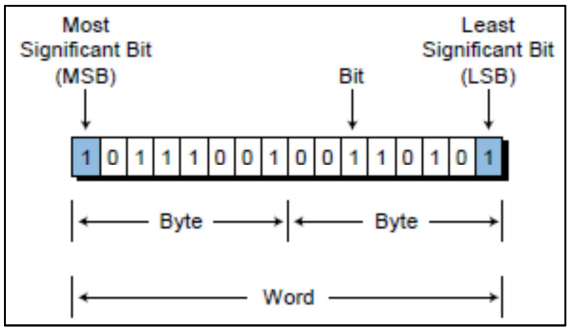


Figure 2.8 A binary number composed of 16 bits

Counting in binary is a little more awkward than counting in decimal for the simple reason that are not used to binary number system. Because the binary number system uses only two digits, can only count from 0 to 1—only one change in one digit location (OFF to ON) before a new digit position must be added.

Conversely, in the decimal system, can count from 0 to 9, equaling ten digit transitions, before a new digit position is added. In binary, just like in decimal, add another digit position once run out of transitions. So, when count in binary, the digit following 0 and 1 is 10 (one-zero, not ten), just like when count 0, 1, 2…9 in decimal, another digit position is added and the next digit is 10 (ten). Table 2.1 shows a count in binary from 0 to 15.

Table 2.1 Decimal and binary counting

Decimal	Binary
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111

CHAPTER 3 METHOD OF OPERATION

3.1 Preparation for building the PLCs Kit

1. Base unit Model Q312B as shown in Figure 3.1
2. GOT1000 model GT1575-VNBA as shown in Figure 3.2
3. Cable GT15-QC30B link between PLC and Touchscreen as shown in Figure 3.3
4. Power supply model Q61P as shown in Figure 3.4
5. CPU unit model Q02HCPU as shown in Figure 3.4
6. Output module model QY50 as shown in Figure 3.4
7. Mistubishi breaker 5A model NF30-CS as shown in Figure 3.5
8. Power supply 24VDC as shown in Figure 3.6
9. Structure of PLC kit and touchscreen as shown in Figure 3.7

All devices are presented in these following figures.

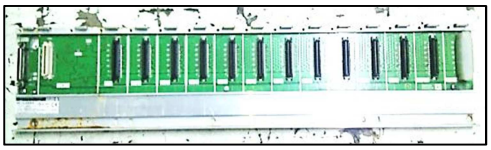


Figure 3.1 Base unit Model Q312B

Figure 3.2 GOT1000 model GT1575-VNBA

Figure 3.3 Cable GT15-QC30B link between PLC and Touchscreen

Figure 3.4 Power supply model Q61P
CPU unit model Q02HCPU
Output module model QY50

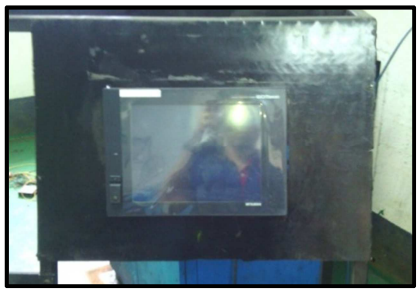
Figure 3.5 Mistubishi breaker 5A model NF30-CS

Figure 3.6 Power supply 24VDC

Figure 3.7 Structure of PLC kit and touchscreen

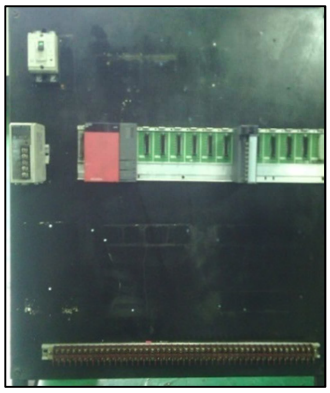
3.2 Building the PLCs Kit

First, the devices of PLC kits are prepared as follows:



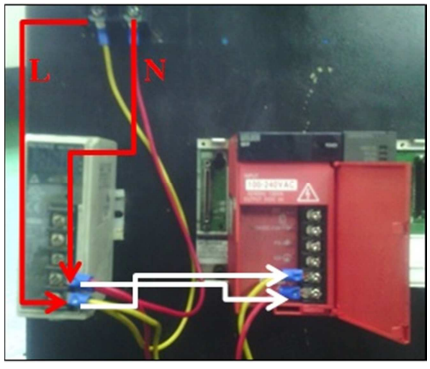
STEP 1: Mount Touchscreen GOT1000 m GT1575-VNBA with the structure by attaching four bolts behind it.

Figure 3.8 STEP 1(PLCs kit)



STEP 2: Install 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 on the structure as illustrated in Figure 3.9.

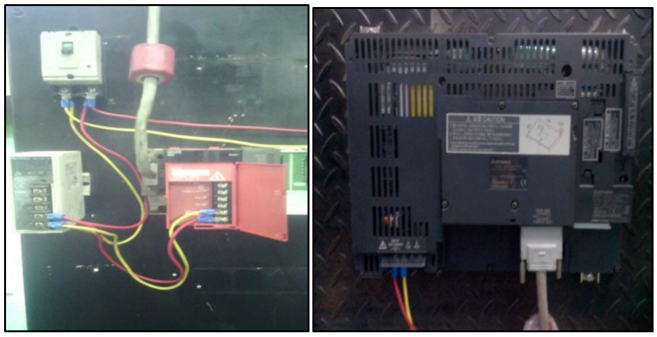
Figure 3.9 STEP 2(PLCs kit)



STEP 3: Wire the control of Mitsubishi breaker 5A model NF30-CS to supply 220 VAC to the power supply 24VDC and power supply model Q61P as represented in Figure 3.10.

Figure 3.10 STEP 3(PLCs kit)

STEP 4: According to Figure 3.11A, wire the control Mitsubishi breaker 5A model NF30-CS generating 220 VAC and GT15-QC30B cable into the back of Touchscreen GOT1000 model GT1575-VNBA as demonstrated in Figure 3.11.



(A) (B)

Figure 3.11 STEP 4 (PLCs kit)

STEP 5: Arrange the wires into appropriate positions for easier use as shown Figure 3.12.

Figure 3.12 STEP 5 (PLCs kit)

STEP 6: The PLC Kit with Touchscreen was completed.

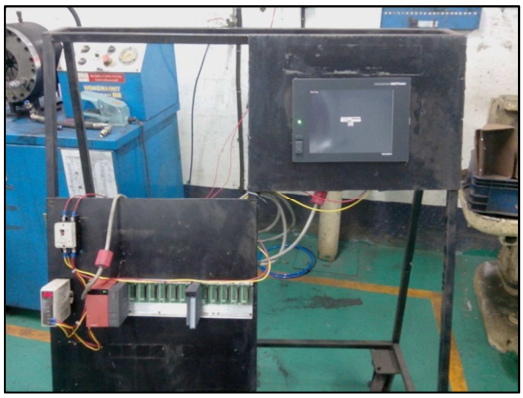


Figure 3.13 STEP 6 (PLCs kit)

CHAPTER 4 EXPERIMENT

This PLC with Touchscreen was tested with real devices and machine used in an industrial factory. However, these specific equipment utilized for developing this Kit were not available in the market because they were specially built to use with the PLC module only.

4.1 Operations of PLC Kit with Touchscreen

Figure 4.1 presented the operation of PLC with Touchscreen used for one machine with a loop feature. The machine could be applied to several models of products. Numeric input was entered through PLC for processing and displaying output on an interface board. Additionally, an installation device was also used to show product's model or part number while the machine was running. The steps of testing were represented in Figure 4.2.

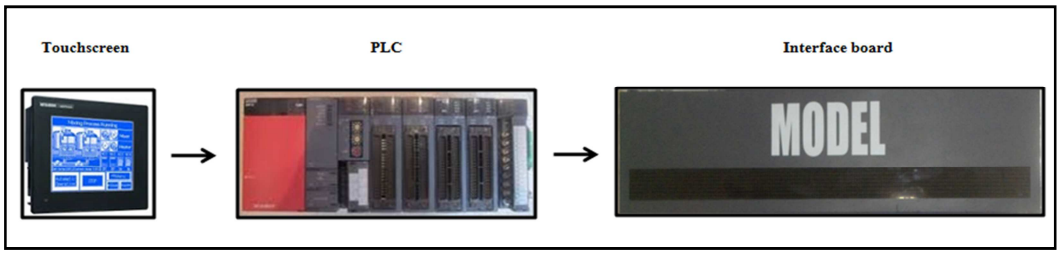


Figure 4.1 Diagram of this project

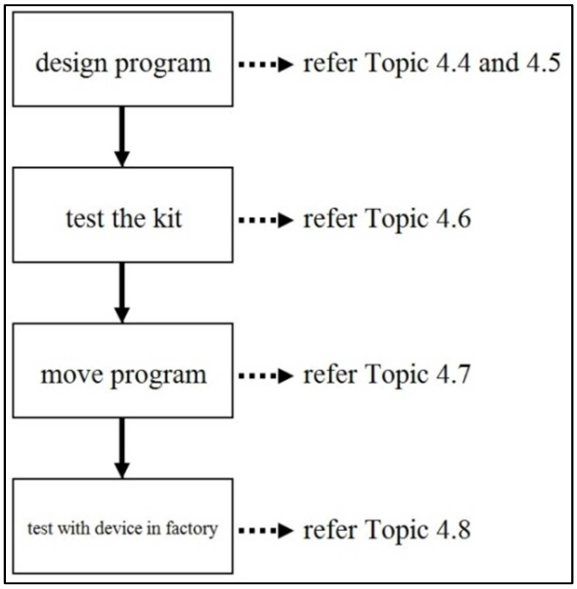


Figure 4.2 Steps of testing

4.2 Checking the details of part numbers

The details of part number could be inspected on Touchscreen. Each part number included different parameters and depended on the size of products.

Table 4.1 Part numbers and product's models

No.	Description	Diameter (mm.)	Number Coiling 1
1	MMTH 4040A254-FR	13.6	345
2	MMTH 4040A256-FR	10.3	381
3	MMTH 4040A259-FR	10.2	380
4	MMTH 4040A260-FR	10.0	379
5	MMTH 4040A262-FR	10.2	465
6	MMTH 4040A263-FR	14.4	344
7	MMTH 4040A313-FR	9.5	385
8	MMTH 4040A319-FR	9.6	386
9	MMTH 4040A325-FR	9.5	384
10	MMTH 4040A328-FR	10.4	342
11	MMTH 4040A329-FR	10.9	338
12	MMTH 4040A403-FR	10.0	426
13	MMTH 4040A332-FR	16.3	86
14	MMTH 4040A333-FR	16.5	94
15	MMTH 4040A334-FR	16.7	96
16	MMTH 4040A335-FR	17.0	98
17	MMTH 4040A336-FR	17.2	43
18	MMTH 4040A337-FR	17.4	44
19	MMTH 4040A342-FR	16.6	85
20	MMTH 4040A344-FR	17.0	95
21	MMTH 4040A345-FR	17.2	99
22	MMTH 4040A346-FR	17.4	100
23	MMTH 4040A347-FR	17.6	119
24	HONDA TG0-T010-RR	10.6	266
25	HONDA TK6-A010-RR	10.7	390
26	HONDA TM0-C010-RR	10.8	399

Table 4.1 Part numbers and product's models (Continued)

No.	Description	Diameter (mm.)	Number Coiling 1
27	HONDA TM0-T020-RR	10.7	268
28	HONDA TM0-T120-RR	10.8	269
29	HONDA TM0-T220-RR	10.5	267
30	HONDA TM0-T310-RR	10.8	279
31	NISSAN 1DJOB-FR	14.3	250
32	NISSAN 1DJOC-FR	14.3	249
33	NISSAN JN80C-FR	14.8	281
34	NISSAN JN80D-FR	14.8	285
35	NISSAN JY20D-FR	14.3	227
36	NISSAN 1DJ0A-FR	15.2	222
37	KAYABA 84003-FR	14.2	48
38	KAYABA 84004-FR	15.3	46
39	SHOWA HTC02-RR	12.0	178
40	SHOWA HTC12-RR	12.0	180
41	MANTUS YARIS-FR35		128
42	MANTUS YARIS-RR35		135
43	TRD-0K039-FR		192
44	TRD-0K040-RR		191
45	TRD-0K048-FR		196
46	MMTH 4040A257-FR		464

4.3 Survey devices before installation

The output of actual module should be checked before the installation. Regarding Figure 4.3, module output in slot base unit was found and spare output in slot 6 was empty. Nevertheless, 6 outputs were required for the test and then Y65, Y66, Y67, Y68, Y69 and Y6A were selected from Figure 4.4.

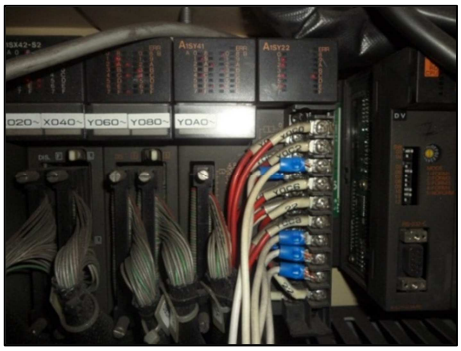


Figure 4.3 PLC module

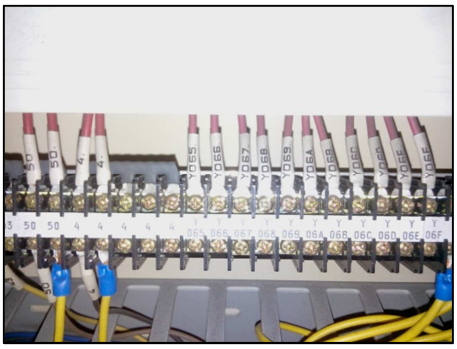
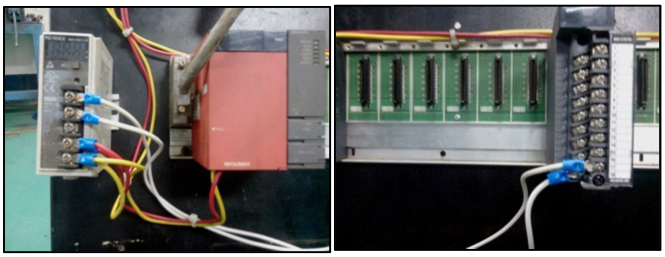


Figure 4.4 Terminal wire jump

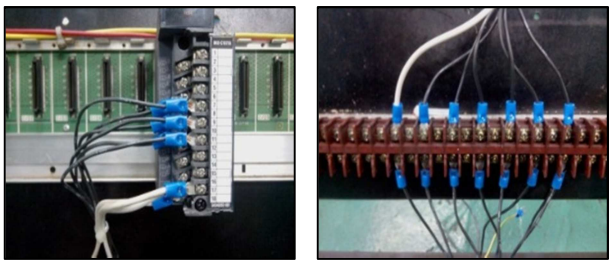
The below figured were examples of circuit wiring in cases used for Interface board testing with the kits. Also, Touchscreen was essential for this experiment to simulate the output of program testing only.



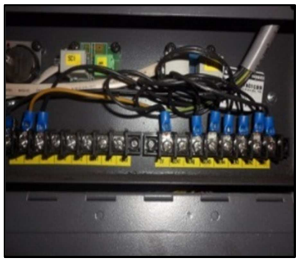
(A) (B)

Figure 4.5 Step 1(example wiring)

Step 1: Wiring from the Power supply 24VDC in Figure 4.5A to the Output module model QY50 in Figure 4.5B.



(A) (B)



(C)

Figure 4.6 Step 2 (example wiring)

Step 2: Wiring from the Output module through Terminal set and to connect the back of Interface board in Figure 4.6.

From Step 1 and 2 could be summarized in a diagram in Figure 4.7.

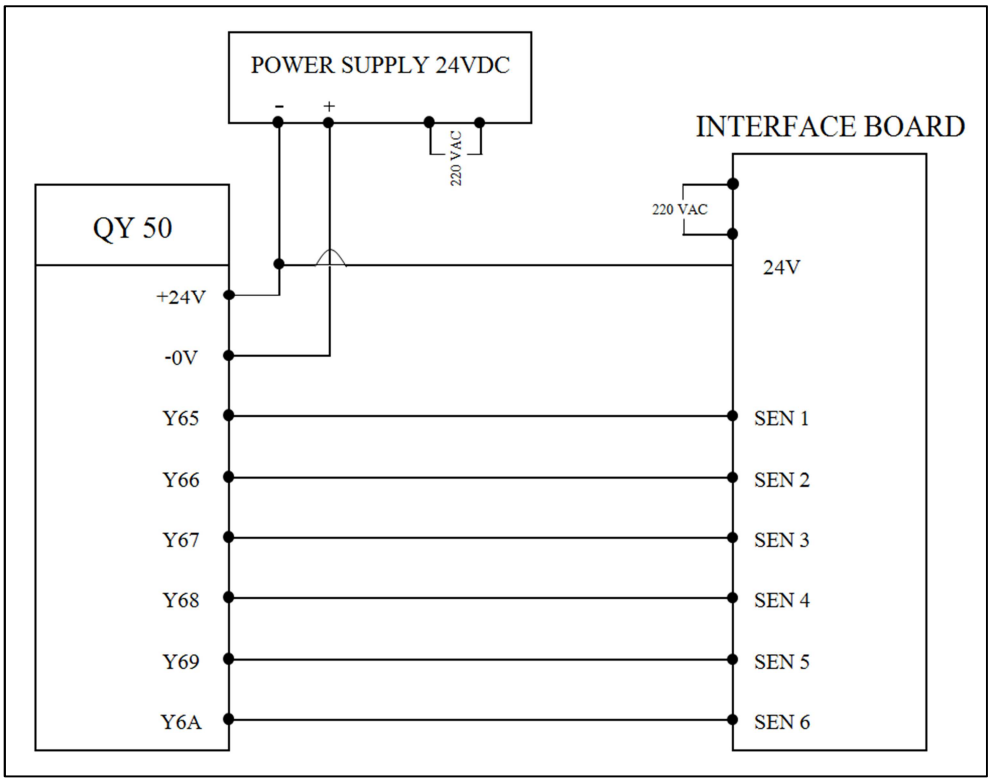


Figure 4.7 wiring diagram for example

4.4 Design Ladder Program of PLC

Before designing the design of ladder diagram, GX developer 8.0 program must be installed as presented in Appendix A to display windows of program as shown in Appendix B. Ladder PLC programming was utilized as BCD number and the arrangement of part number from the beginning to the end was shown in Table 4.2.

Table 4.2 Output from applying 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
6	344	0	0	0	1	1	0

Table 4.2 Output from applying BCD method (Continued)

No.	Program No.	Y6A	Y69	Y68	Y67	Y66	Y65
7	385	0	0	0	1	1	1
8	386	0	0	1	0	0	0
9	384	0	0	1	0	0	1
10	342	0	0	1	0	1	0
11	338	0	0	1	0	1	1
12	426	0	0	1	1	0	0
13	86	0	0	1	1	0	1
14	94	0	0	1	1	1	0
15	96	0	0	1	1	1	1
16	98	0	1	0	0	0	0
17	43	0	1	0	0	0	1
18	44	0	1	0	0	1	0
19	85	0	1	0	0	1	1
20	95	0	1	0	1	0	0
21	99	0	1	0	1	0	1
22	100	0	1	0	1	1	0
23	119	0	1	0	1	1	1
24	266	0	1	1	0	0	0
25	390	0	1	1	0	0	1
26	399	0	1	1	0	1	0
27	268	0	1	1	0	1	1
28	269	0	1	1	1	0	0
29	267	0	1	1	1	0	1
30	279	0	1	1	1	1	0
31	250	1	1	1	1	1	1
32	249	1	0	0	0	0	0
33	281	1	0	0	0	0	1
34	285	1	0	0	0	1	0
35	227	1	0	0	0	1	1
36	222	1	0	0	1	0	0
37	48	1	0	0	1	0	1
38	46	1	0	0	1	1	0
39	178	1	0	0	1	1	1

Table 4.2 Output from applying BCD method (Continued)

No.	Program No.	Y6A	Y69	Y68	Y67	Y66	Y65
40	180	1	0	1	0	0	0
41	128	1	0	1	0	0	1
42	135	1	0	1	0	1	0
43	192	1	0	1	0	1	1
44	191	1	0	1	1	0	0
45	196	1	0	1	1	0	1
46	464	1	0	1	1	1	0

Table 4.2 demonstrated the amount of data in each output. The output in columns Y65, Y66, Y67, Y68 and Y6A was the number of members that must be applied to programming.

Table 4.3 Number of members in each output

Output	Number of members in each output
Y65	340, 380, 465, 385, 384, 338, 86, 96, 43, 85, 99, 119, 390, 268, 267, 250, 281, 227, 48, 178, 128, 192, 196
Y66	381, 380, 344, 385, 342, 338, 94, 96, 44, 85, 100, 119, 399, 268, 279, 250, 285, 227, 46, 178, 135, 192, 464
Y67	379, 465, 344, 385, 426, 86, 94, 96, 44, 85, 100, 119, 269, 267, 279, 250, 222, 48, 46, 178, 191, 196, 464
Y68	386, 384, 342, 338, 426, 86, 94, 96, 266, 390, 399, 268, 269, 267, 279, 250, 180, 128, 135, 192, 191, 196, 464
Y69	98, 43, 44, 85, 95, 99, 100, 119, 266, 390, 399, 268, 269, 267, 279, 250
Y6A	249, 281, 285, 227, 222, 48, 46, 178, 180, 128, 135, 192, 191, 196, 464

Table 4.3 illustrated the number of members in each output that could be programmed for Ladder Diagram to 6 outputs as follows:

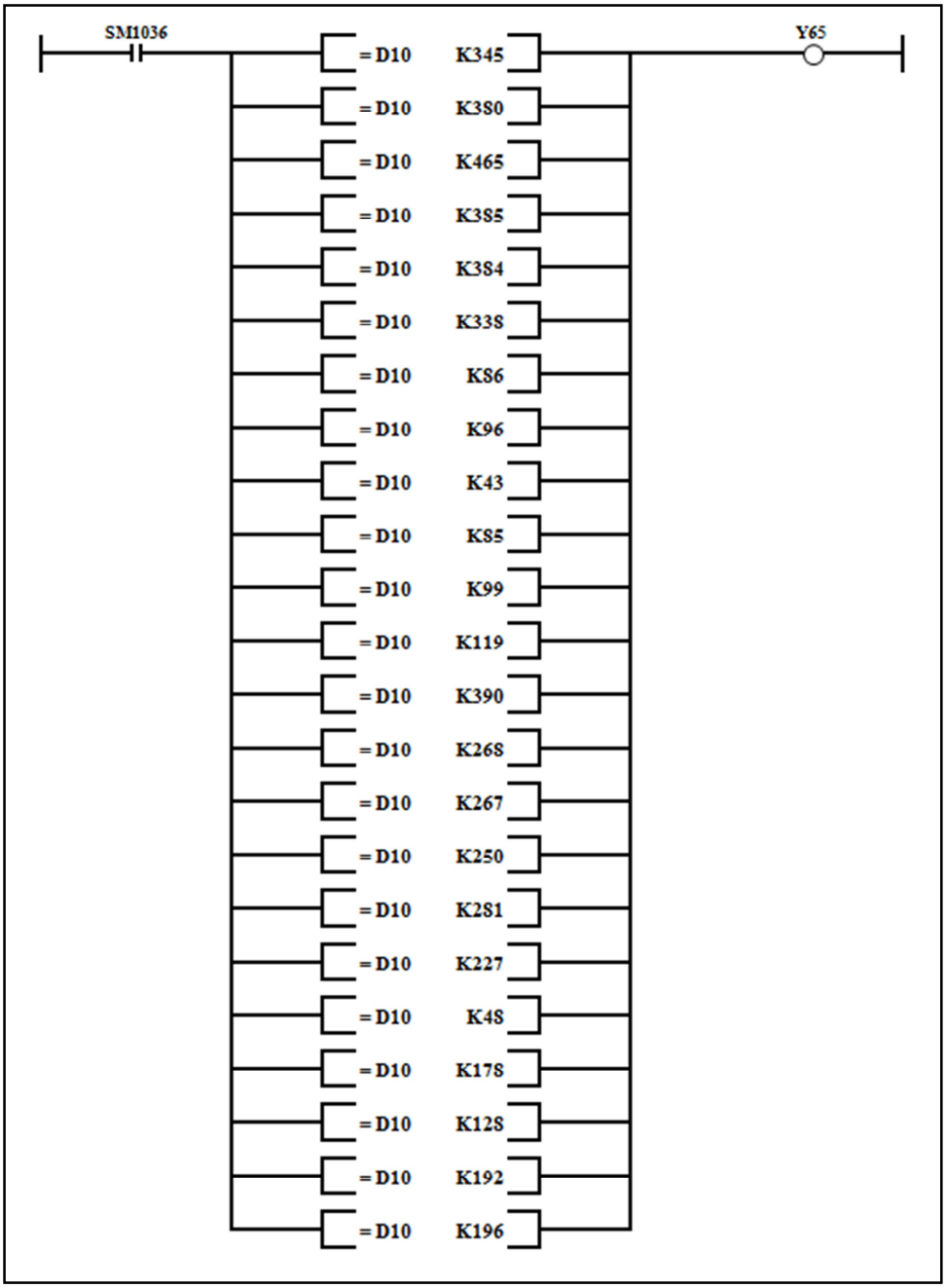


Figure 4.8 Ladder diagram of Output Y65

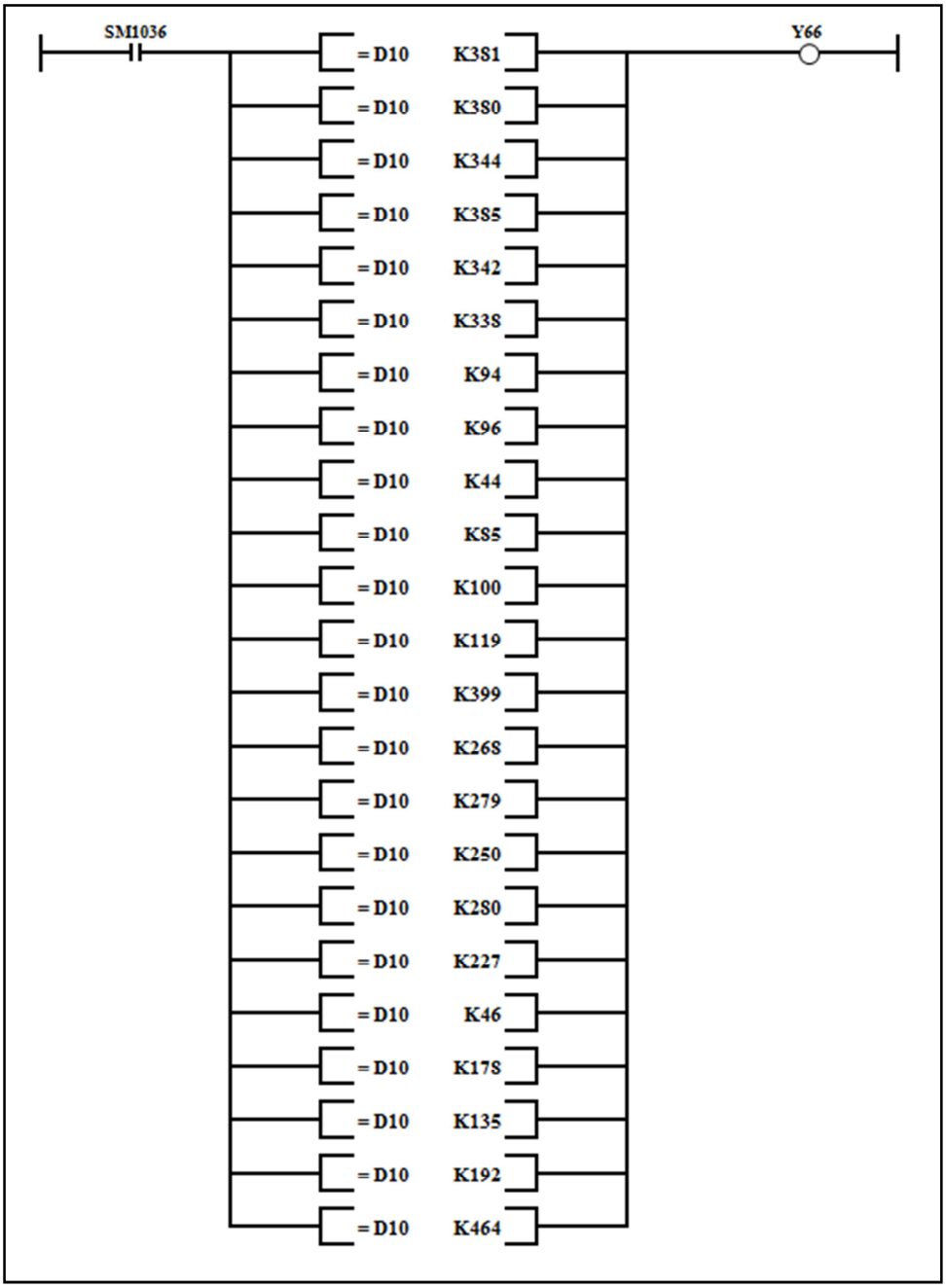


Figure 4.9 Ladder diagram of Output Y66

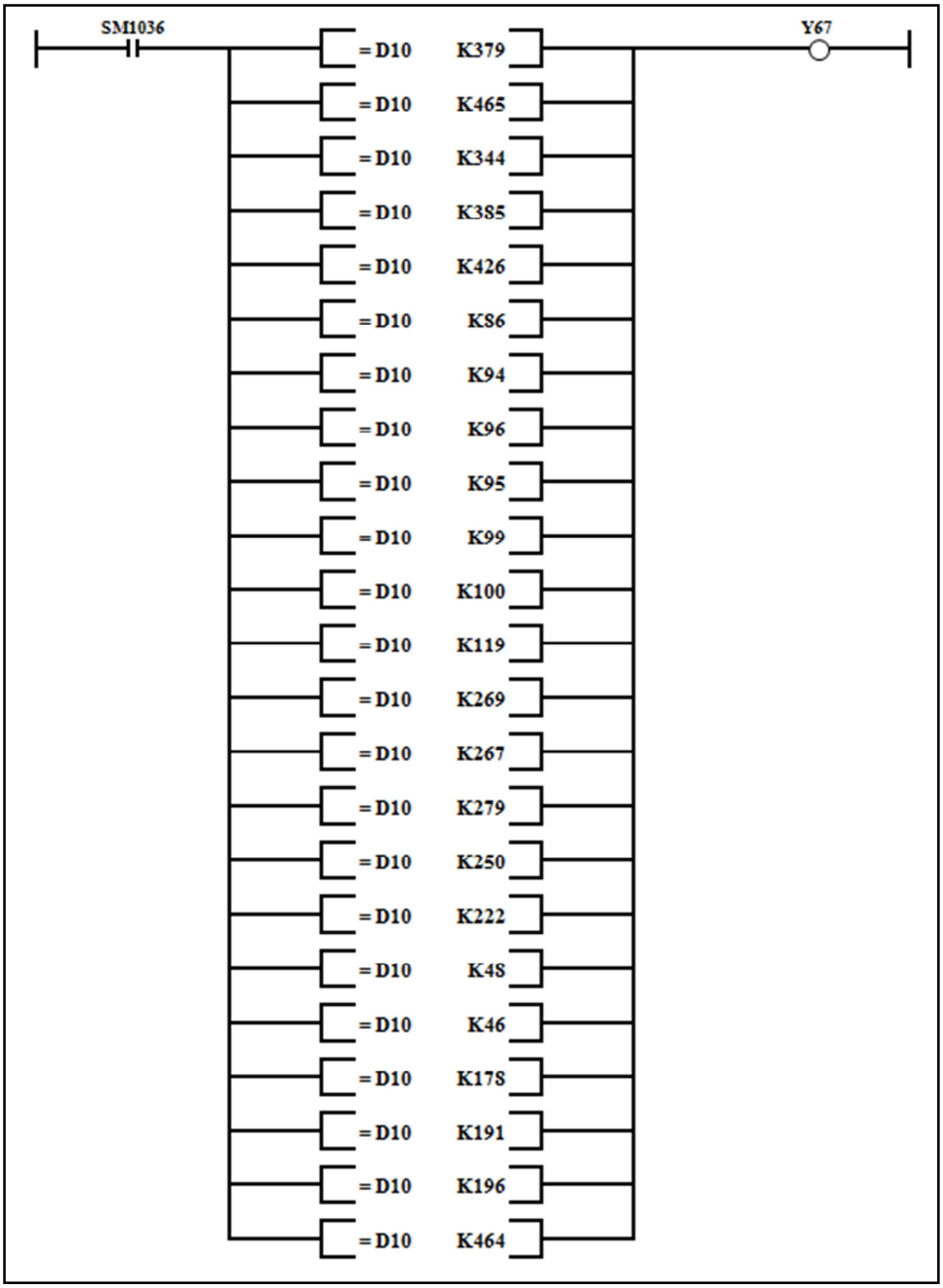


Figure 4.10 Ladder diagram of Output Y67

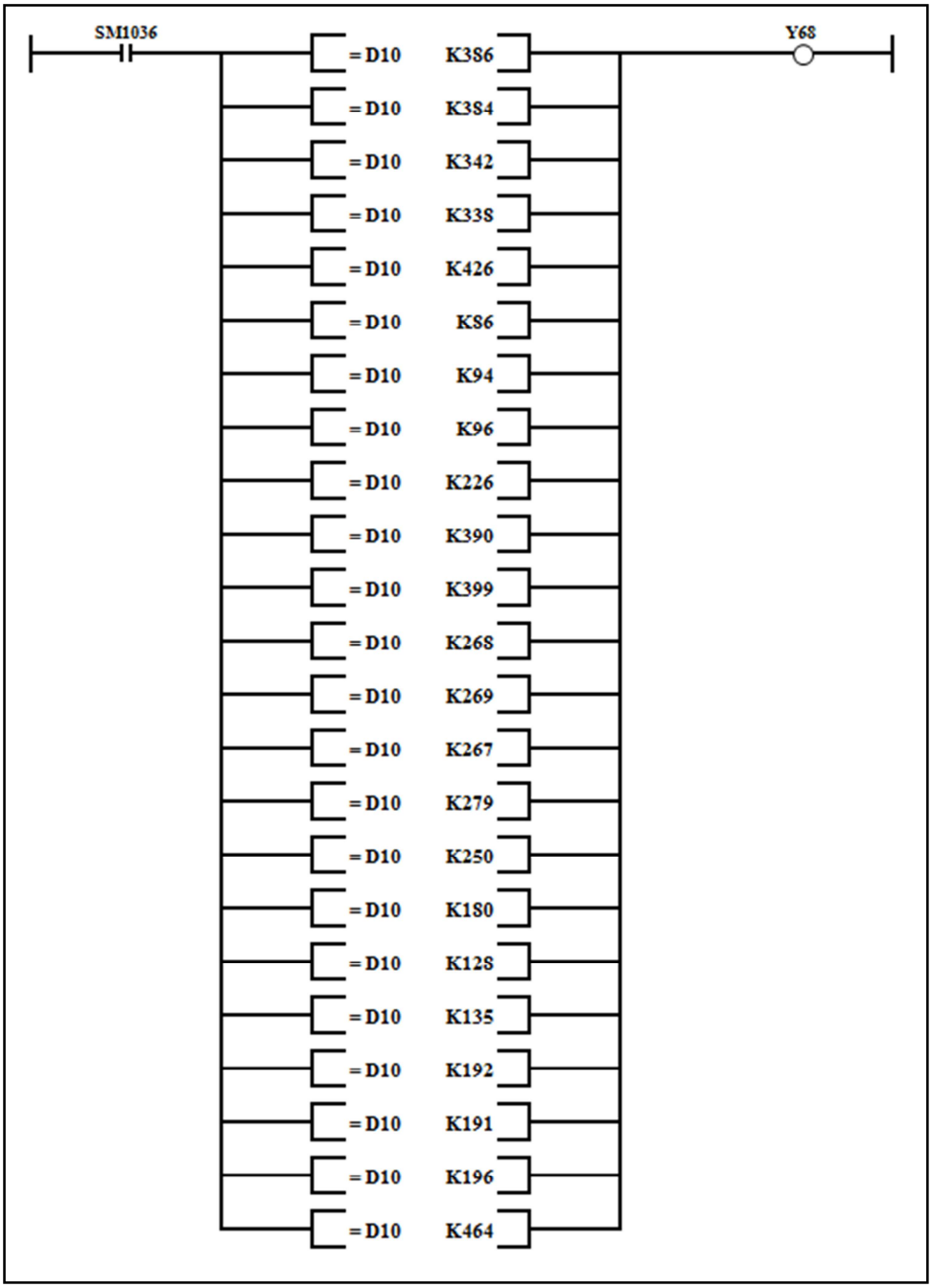


Figure 4.11 Ladder diagram of Output Y68

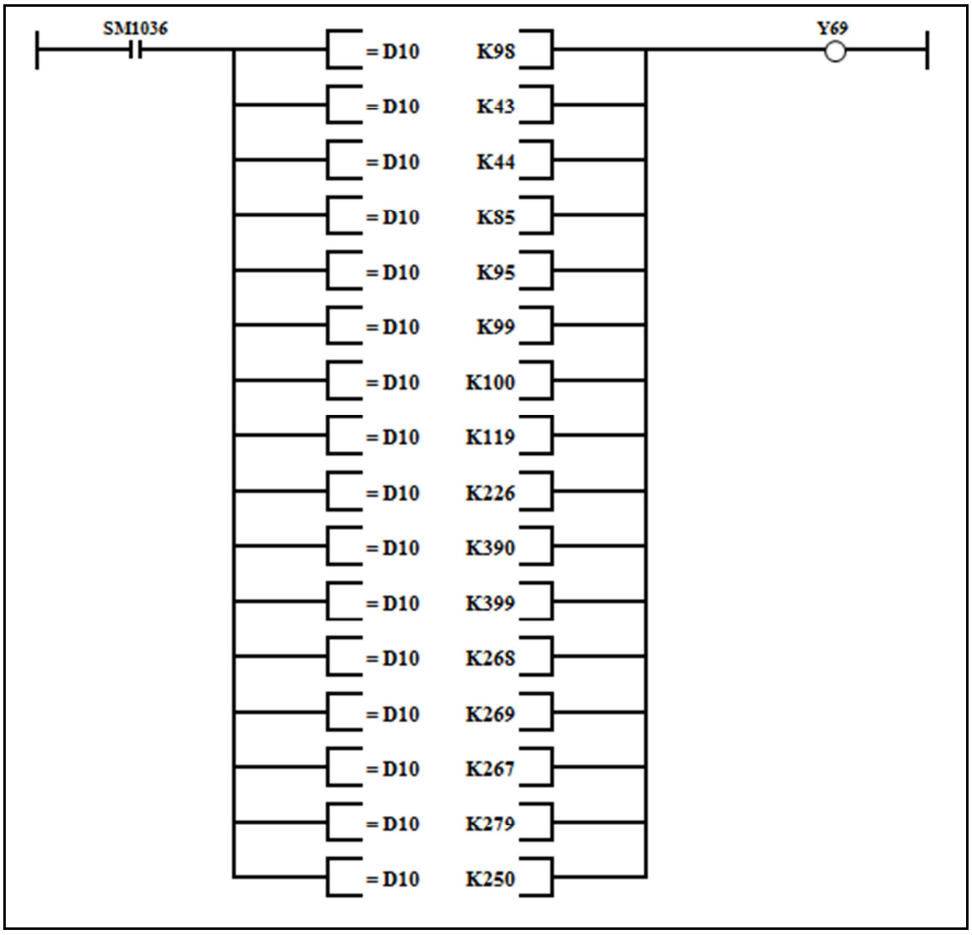


Figure 4.12 Ladder diagram of Output Y69

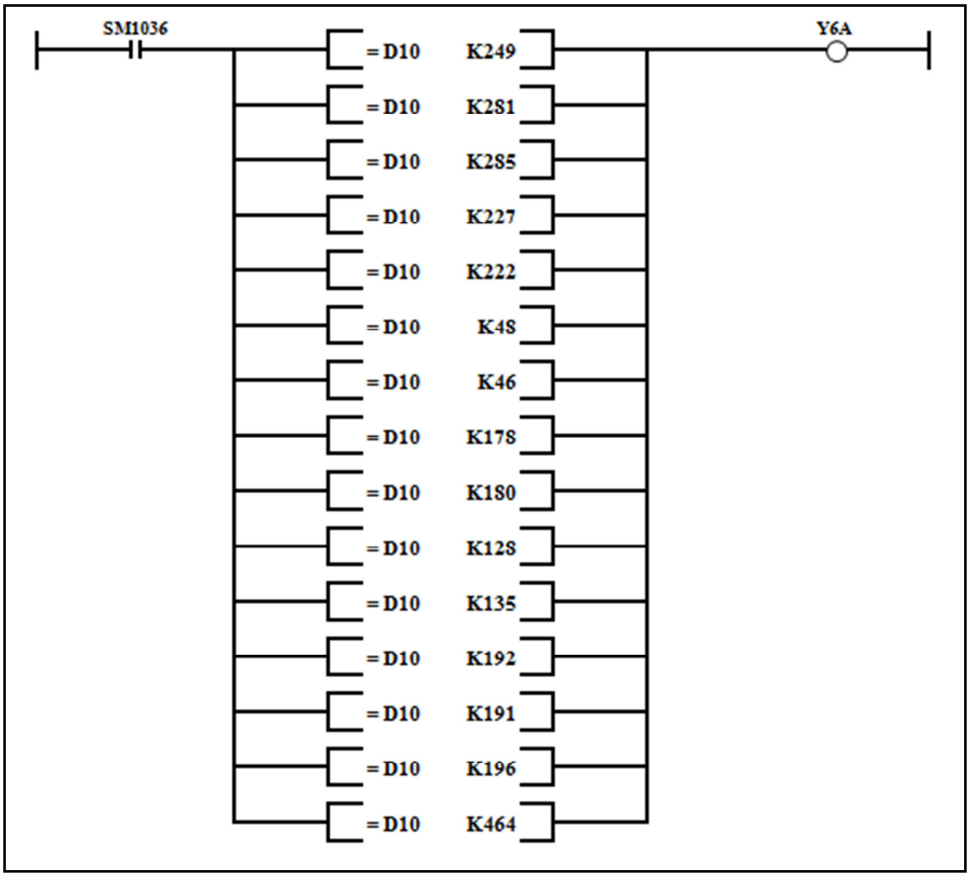


Figure 4.13 Ladder diagram of Output Y6A

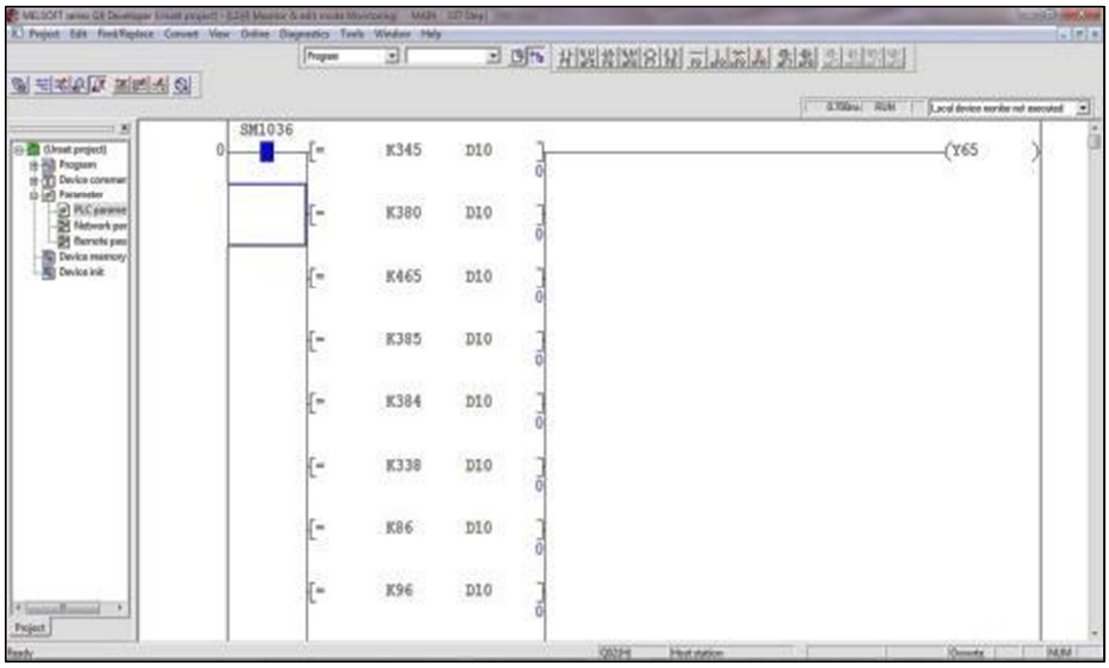
According to the above Ladder Diagram, there were similar operations in each output since SM1036 which was always Close command and operated when using the power supply to PLC. Besides, input D10 command for Touchscreen was a variable or comparator. The Ladder Diagram was configured to match defined number and it would operate when D10 was equal to the set number.

After designing program, Touchscreen was connected to a laptop by using USB cable as presented in Figure 4.14.

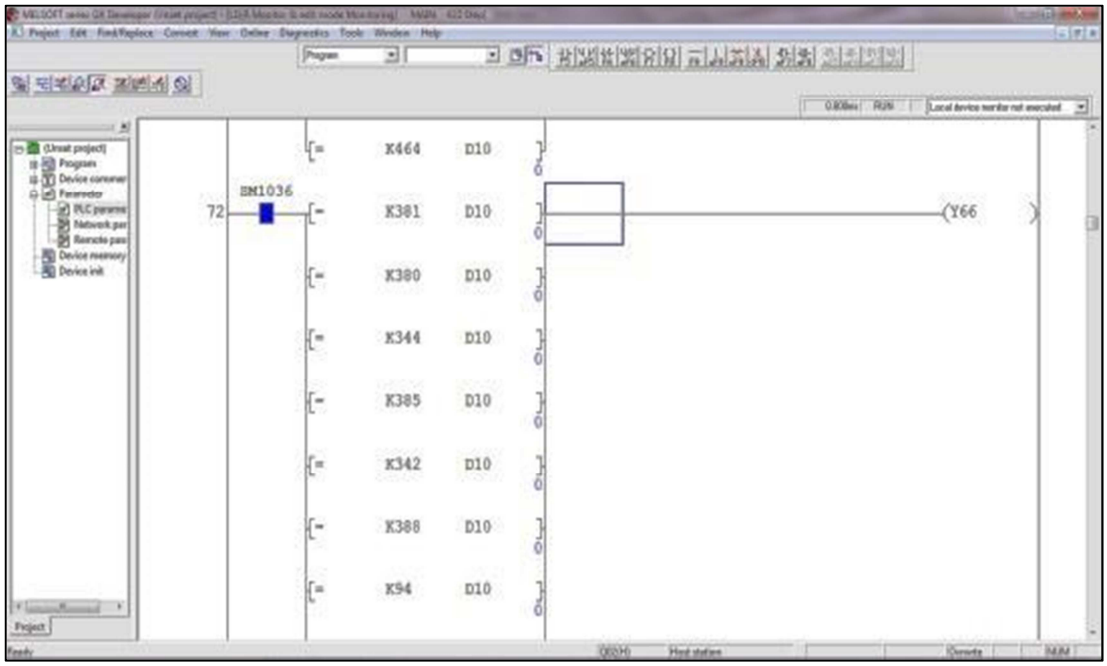
(A) (B)

Figure 4.14 Connection between laptop and Touchscreen

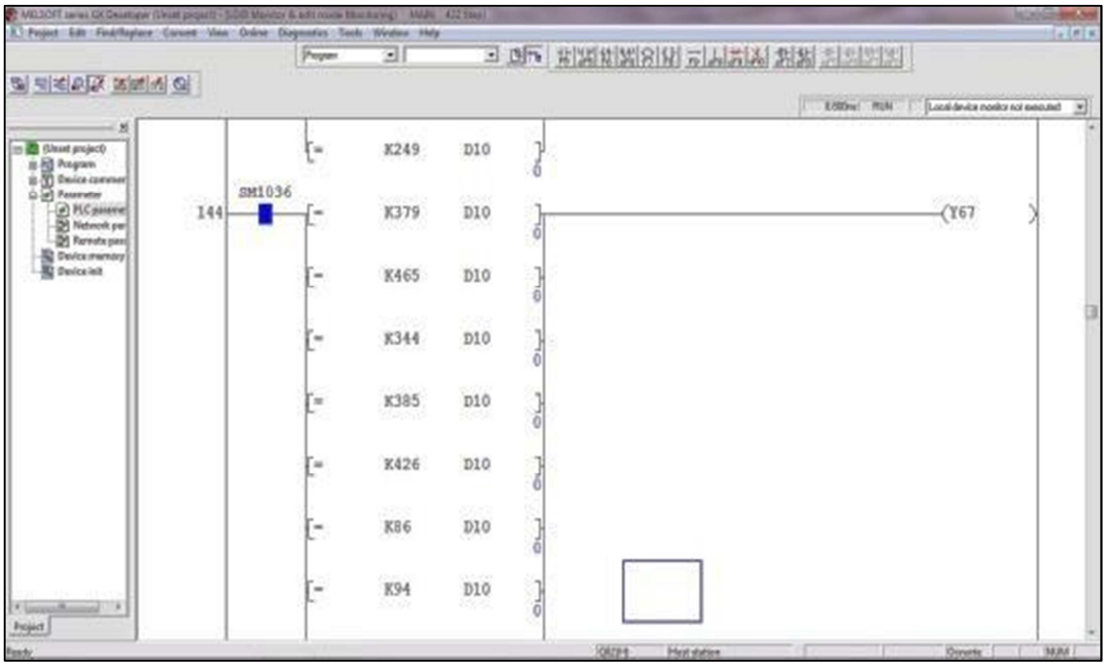
Figure 4.14 illustrated the connection between laptop and Touchscreen. Then the designed program was applied to software called “GX Developer 8.0” as shown in Figure 36.



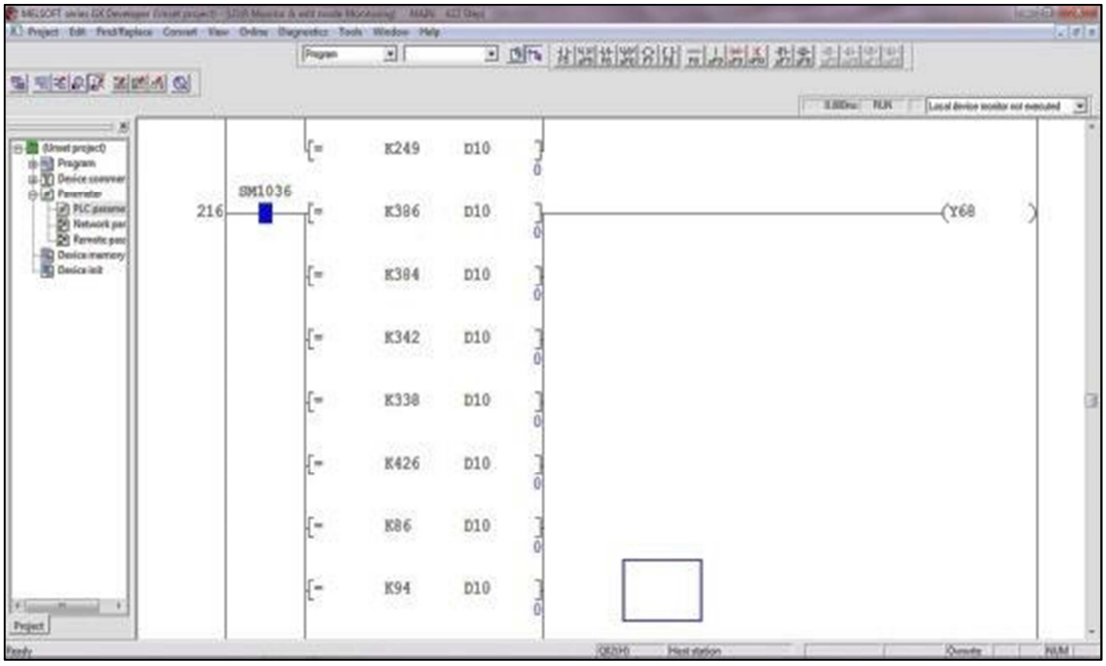
(A)



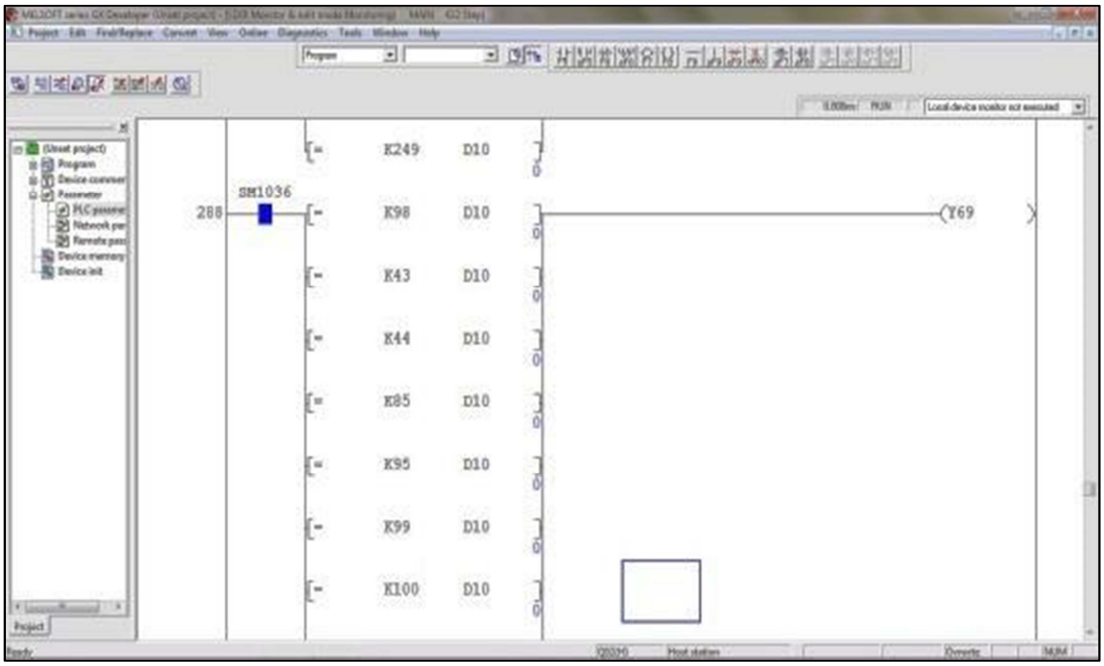
(B)


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

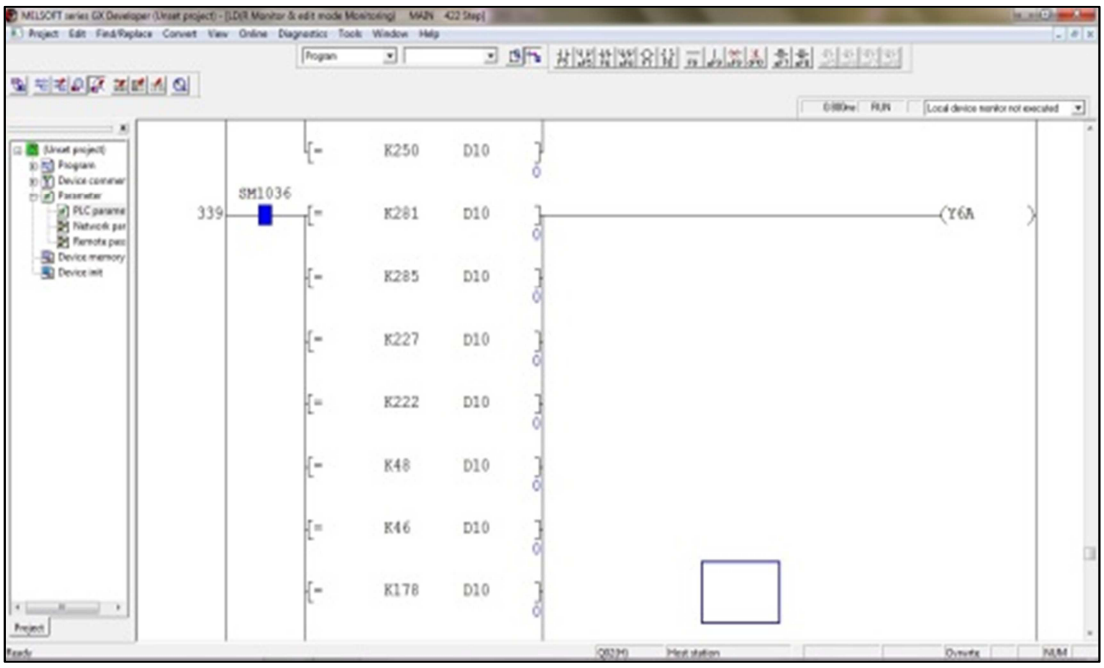
(C)


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

(D)



(E)



(F)

Figure 4.15 (A-F) Ladder Diagram of GX Developer 8.0

4.5 Design Touchscreen by GT Designer 2

GT Designer 2 must be installed in Touchscreen before designing as described in Appendix C. After that, certain parameters were similarly fixed to the hardware as represented in Appendix D. Touchscreen in Figure 4.16 was utilized to test PLC

program and enter the numeric input as well. The output in circles consisted of 6 outputs; Y65, Y66, Y67, Y68, Y69 and Y6A. When the status of output was ON, the operational status would be displayed in orange and black if it was OFF.

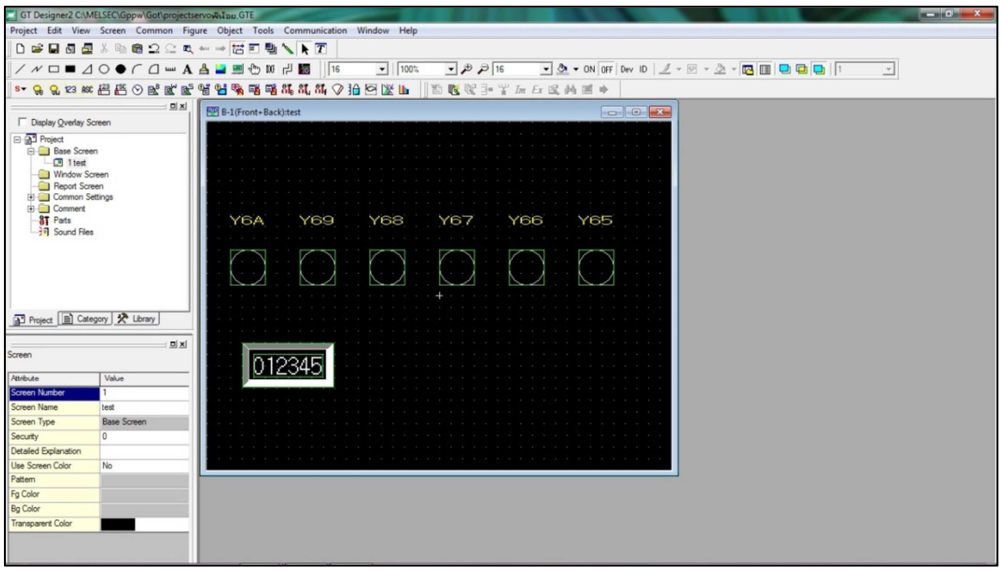


Figure 4.16 Design Touchscreen by GT Designer 2

4.6 Checking program

Regarding program number in Table 4.2, the program was checked before entering the input through Touchscreen. The output were presented in Table 4.2 also. If the output was ON, it equaled to 1 and stayed orange. Otherwise, if the output was OFF, it equaled to 0 and stayed black. An additional example of program checking was presented in Figure 4.17.

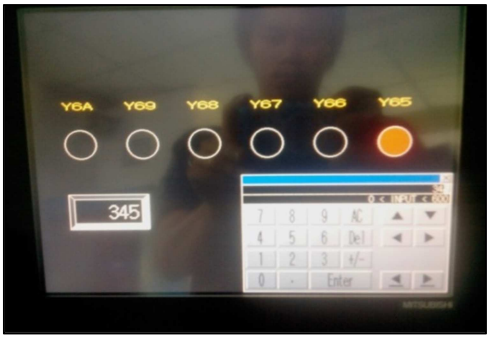
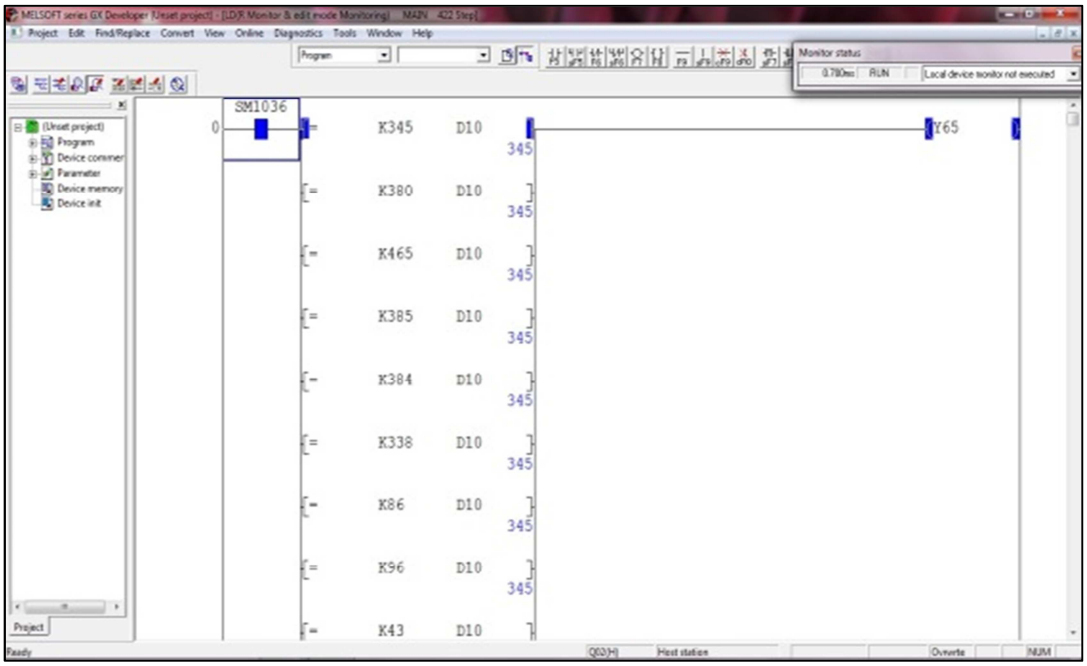
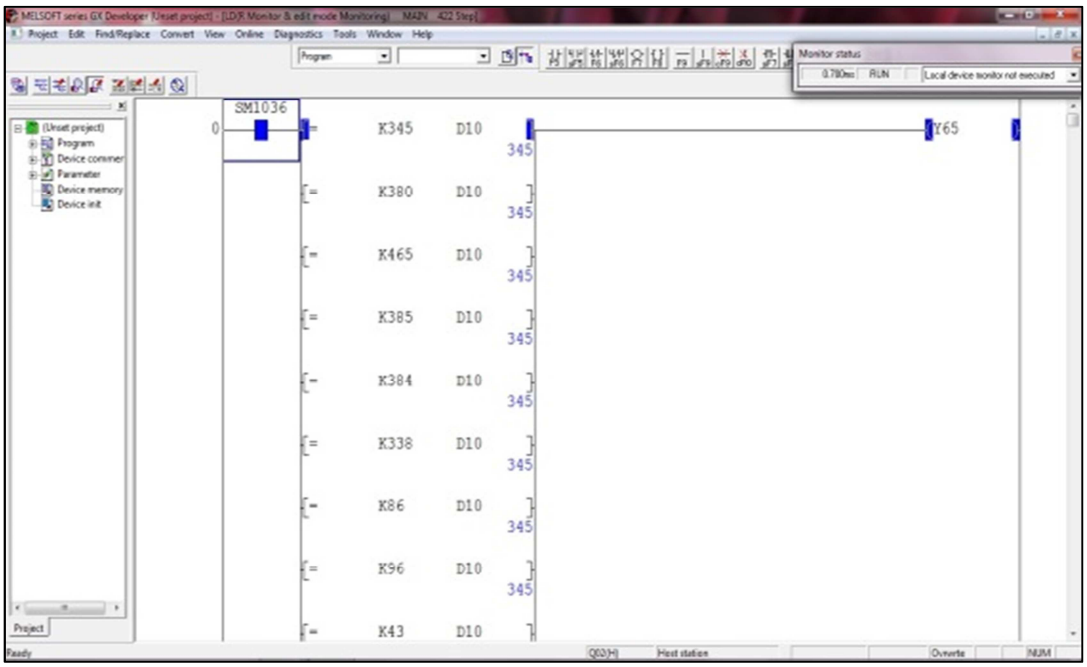


Figure 4.17 Checking program no. 345

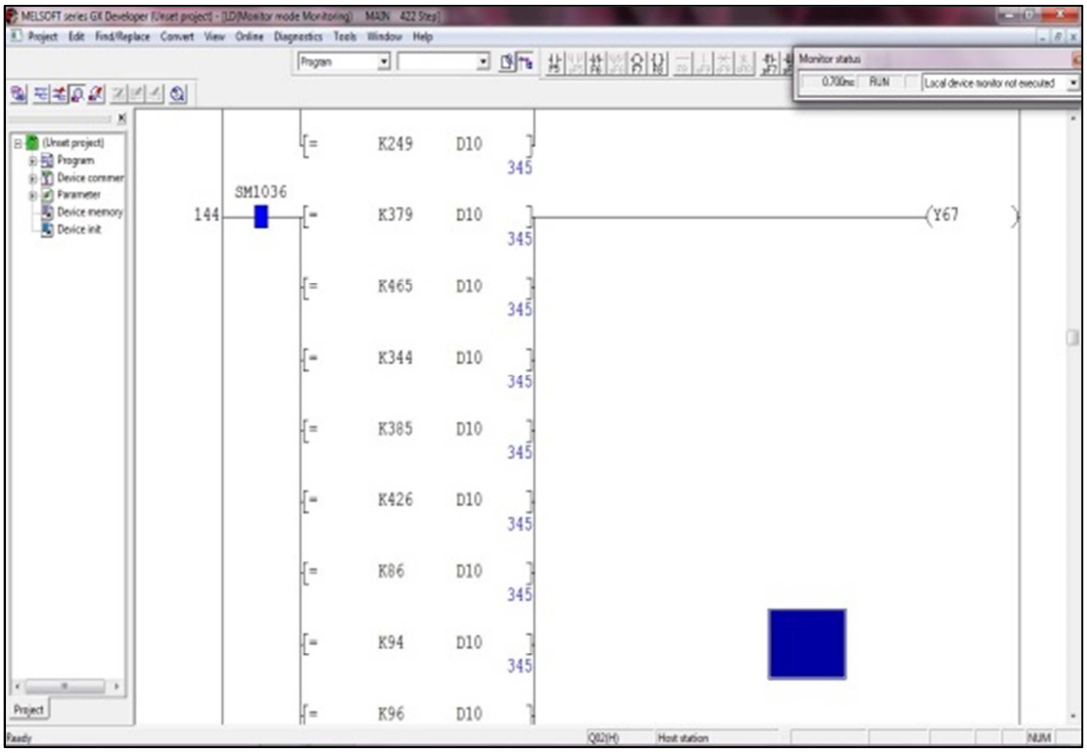
According to Figure 4.17, and next checking operation of program is accuracy or not.


SM1036
K345 D10
K380 D10
K465 D10
K385 D10
K384 D10
K338 D10
K86 D10
K96 D10
K43 D10
Y65
345

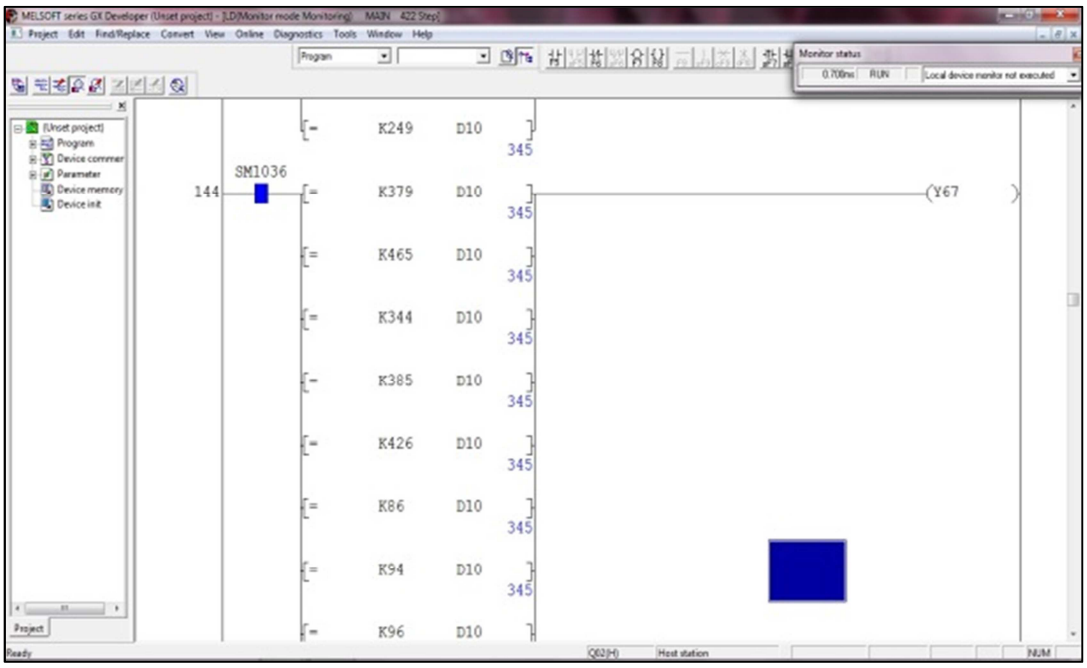
(A)


SM1036
K345 D10
K380 D10
K465 D10
K385 D10
K384 D10
K338 D10
K86 D10
K96 D10
K43 D10
Y65
345

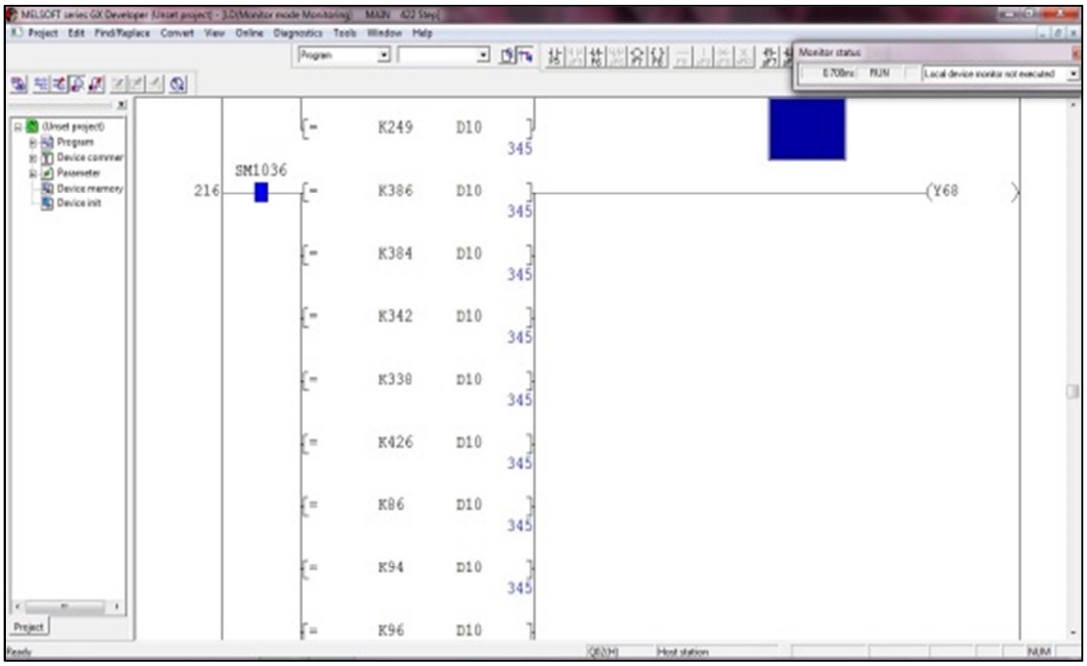
(B)


MELSOFT series GX Developer (Unset project) - [LD(Monitor mode Monitoring) MAIN 422 Step]
Project Edit Find/Replace Convert View Online Diagnostics Tools Window Help
Program
Monitor status
0.709ms RUN Local device monitor not executed
(Unset project)
Program
Device comment
Parameter
Device memory
Device init
Project
SM1036
144
K249 D10
345
K379 D10
345
K465 D10
345
K344 D10
345
K385 D10
345
K426 D10
345
K86 D10
345
K94 D10
345
K96 D10
Y67
Ready
Q02(H)
Host station
NUM

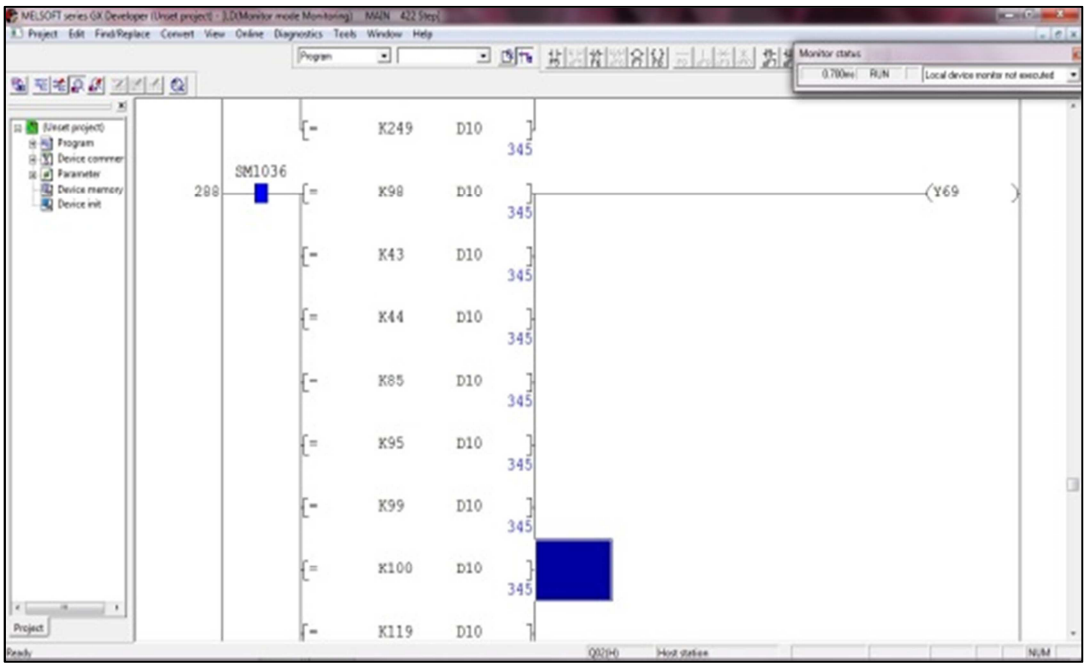
(C)


MELSOFT series GX Developer (Unset project) - [LD(Monitor mode Monitoring) MAIN 422 Step]
Project Edit Find/Replace Convert View Online Diagnostics Tools Window Help
Program
Monitor status
0.709ms RUN Local device monitor not executed
(Unset project)
Program
Device comment
Parameter
Device memory
Device init
Project
SM1036
144
K249 D10
345
K379 D10
345
K465 D10
345
K344 D10
345
K385 D10
345
K426 D10
345
K86 D10
345
K94 D10
345
K96 D10
Y67
Ready
Q02(H)
Host station
NUM

(D)



(E)

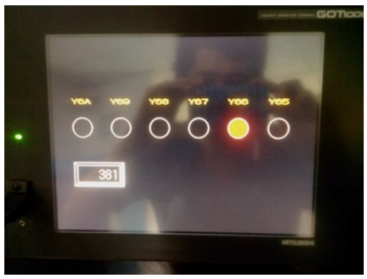


(F)

Figure 4.18 Checking operation of program

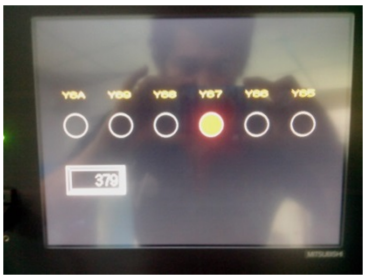
In Figure 4.18, the entered input was 345 and the operated output was Y65. However, other outputs like Y66, Y67, Y68, Y69 and Y6A were not chosen while BCD was transformed to 000001. Therefore, the result compared to Table 4.2 was correct.

The overall checking could be conducted by entering all data as shown in Table 4.2. It was useful to investigate the accuracy of program before applying to real device as presented in Figure 4.19. The steps of checking were designed regarding Table 4.2.

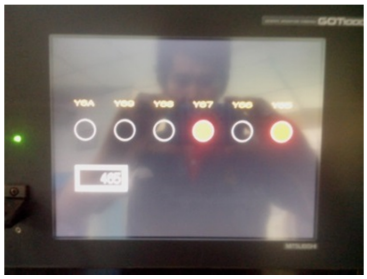


(A)

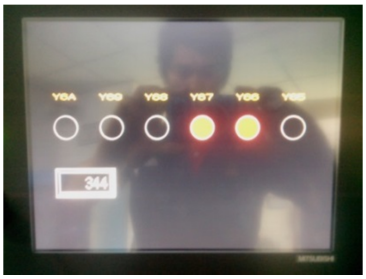
(B)



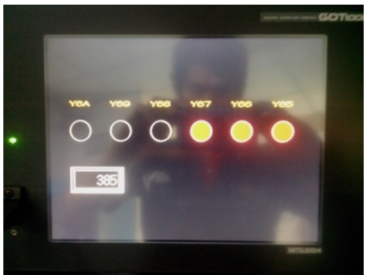
(C)



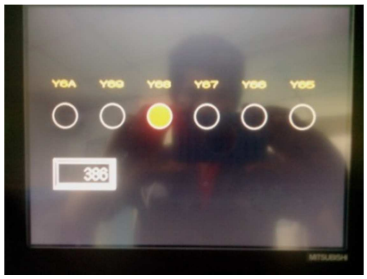
(D)



(E)

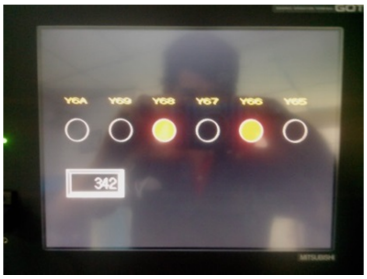


(F)

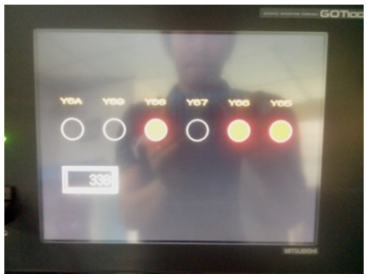


(G)

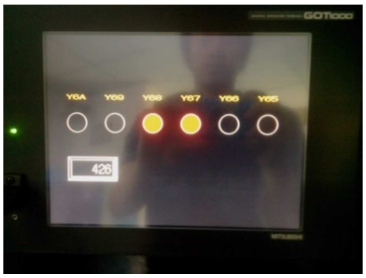
(H)



(I)

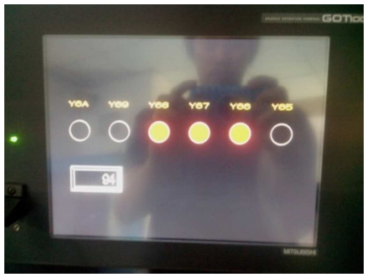


(J)

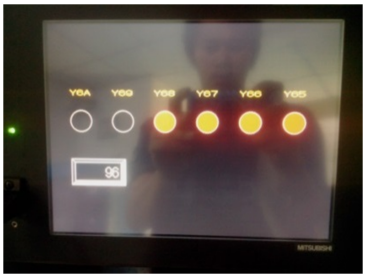


(K)

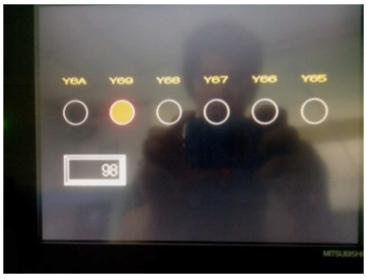
(L)



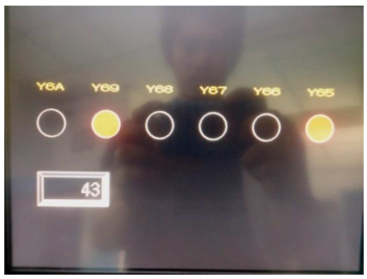
(M)



(N)

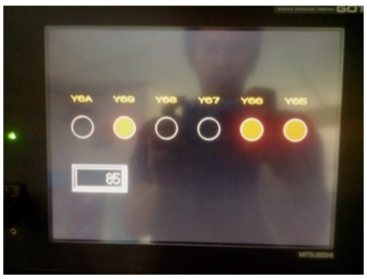


(O)

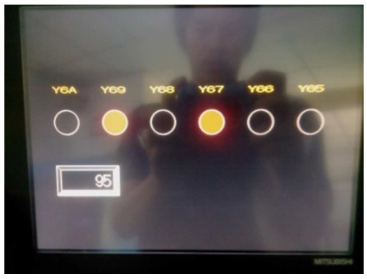


(P)

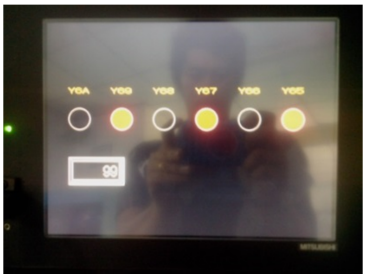
(Q)



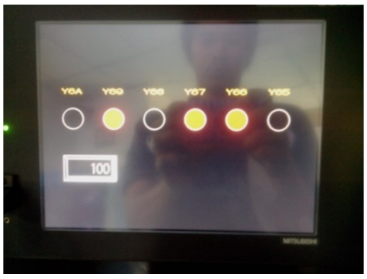
(R)



(S)



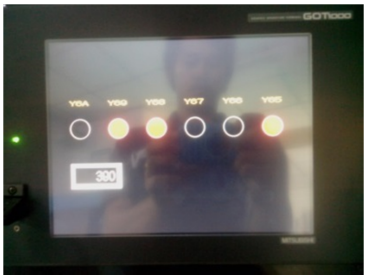
(T)



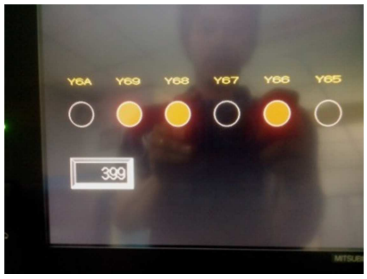
(U)

(V)

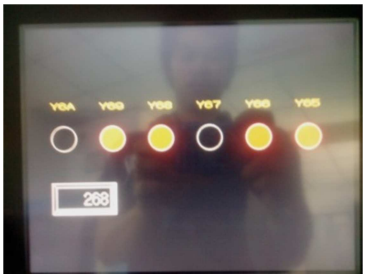
(W)



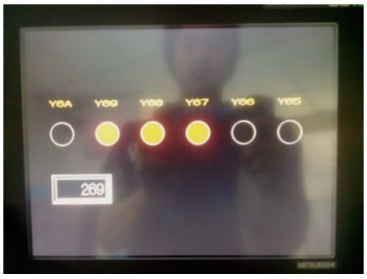
(X)



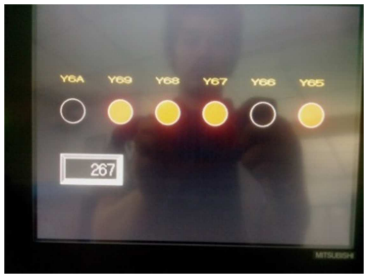
(Y)



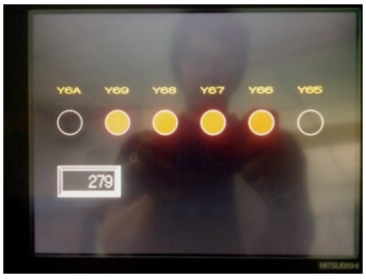
(Z)



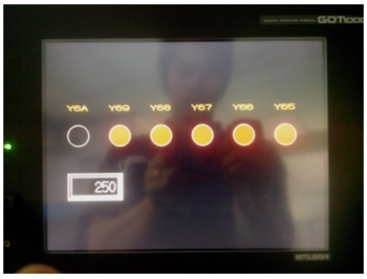
(AA)



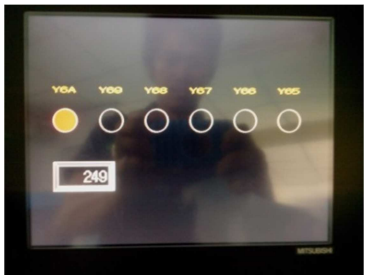
(AB)



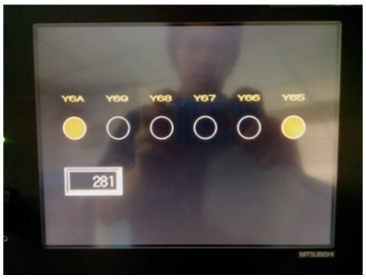
(AC)



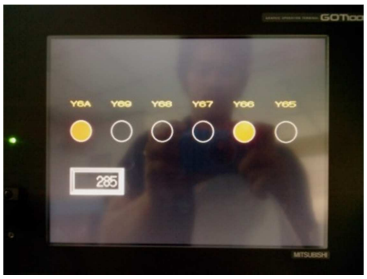
(AD)



(AE)

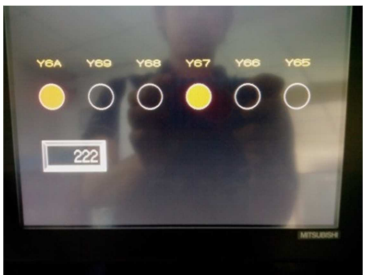


(AF)

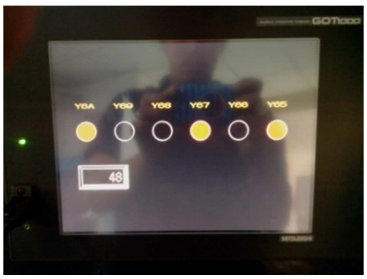


(AG)

(AH)

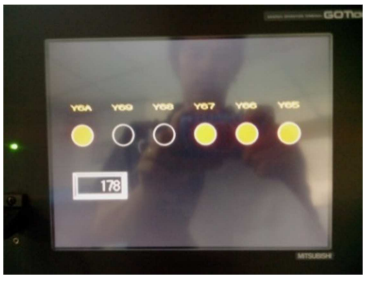


(AI)

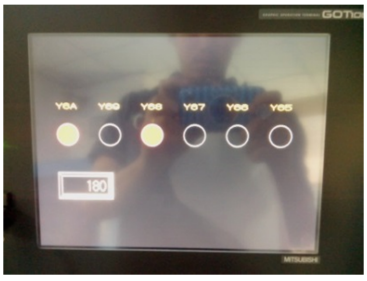


(AJ)

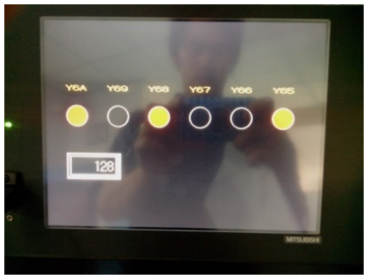
(AK)



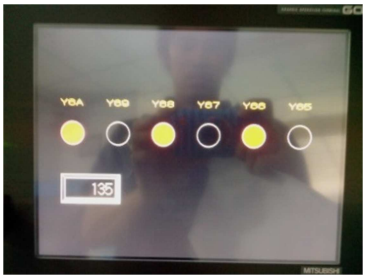
(AL)



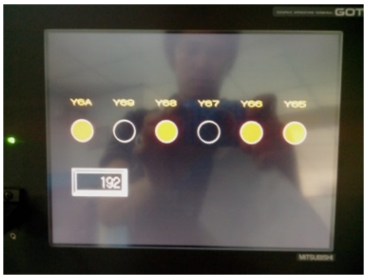
(AM)



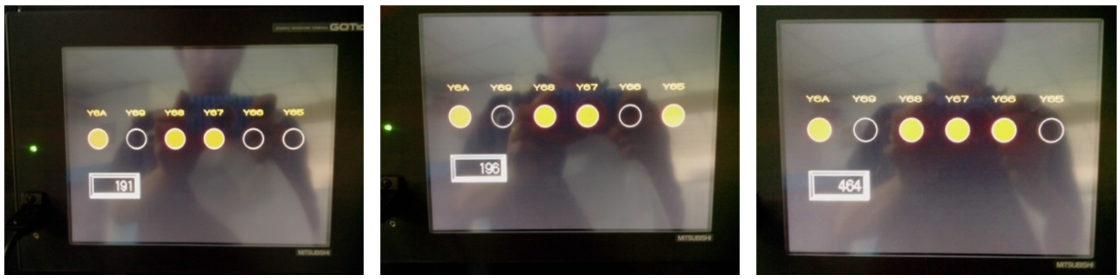
(AN)



(AO)



(AP)



(AQ) (AR) (AS)

Figure 4.19 (A-AS) Output according to Table 4.2

4.7 Application with real devices

In topic 4.3 the program was tested with real devices as illustrated in Figure 4.3 and 4.4. Then a wiring circuit was added for the installation as represented in Figure 4.20.

(A) (B) (C)

Figure 4.20 Installation of additional devices

Regarding Figure 4.20, a diagram of wiring circuit could be written following Figure 4.21 and 4.22.

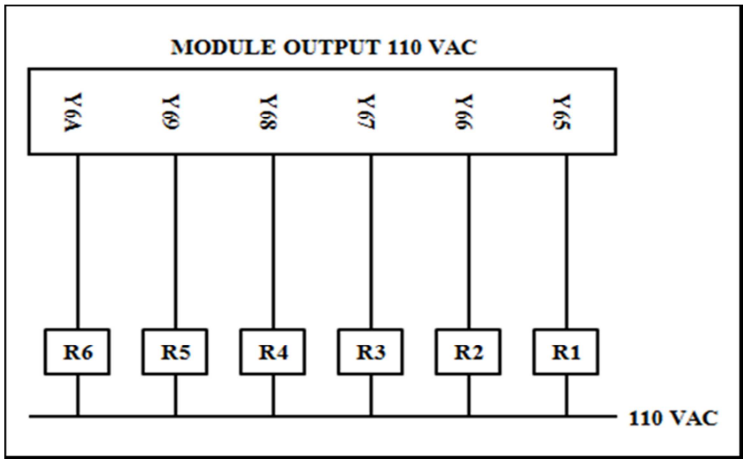


Figure 4.21 Circuit wiring of Output module

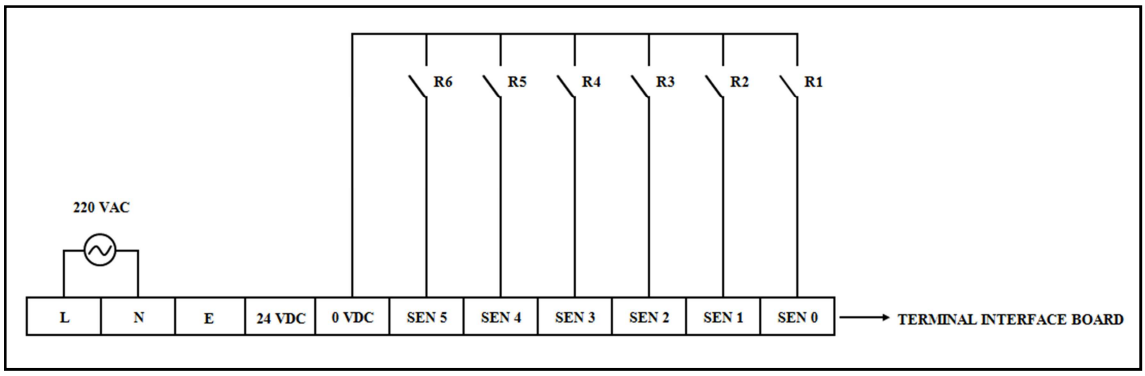


Figure 4.22 Circuit wiring of Interface board

Then, PLC program of machine was upload to open with the designed program together by using ‘move’, ‘copy’ and ‘paste’ commands as following steps;

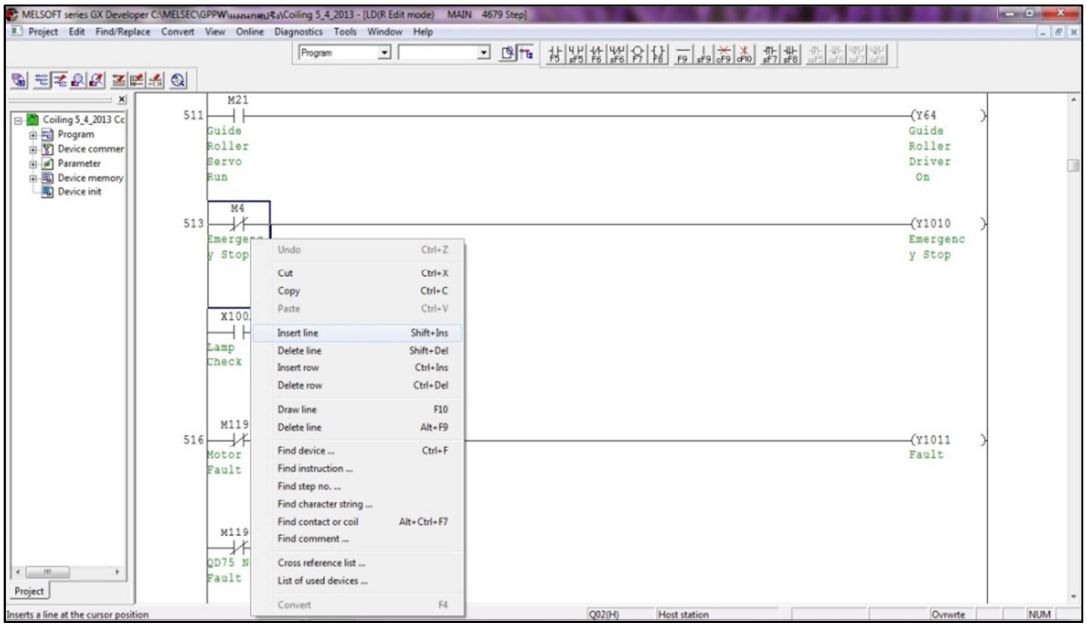


Figure 4.23 Step 1(copy and paste)

In Figure 4.23, right click and select “insert line” to increase space and insert ladder.

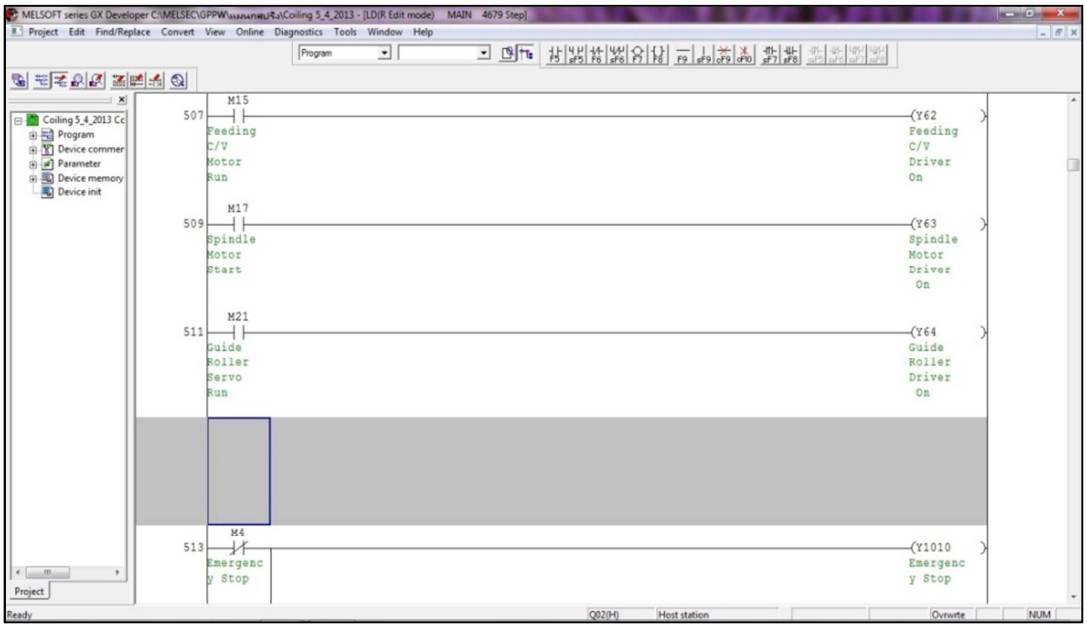


Figure 4.24 Step 2 (copy and paste)

As shown in Figure 4.24, additional space to insert ladder appeared.

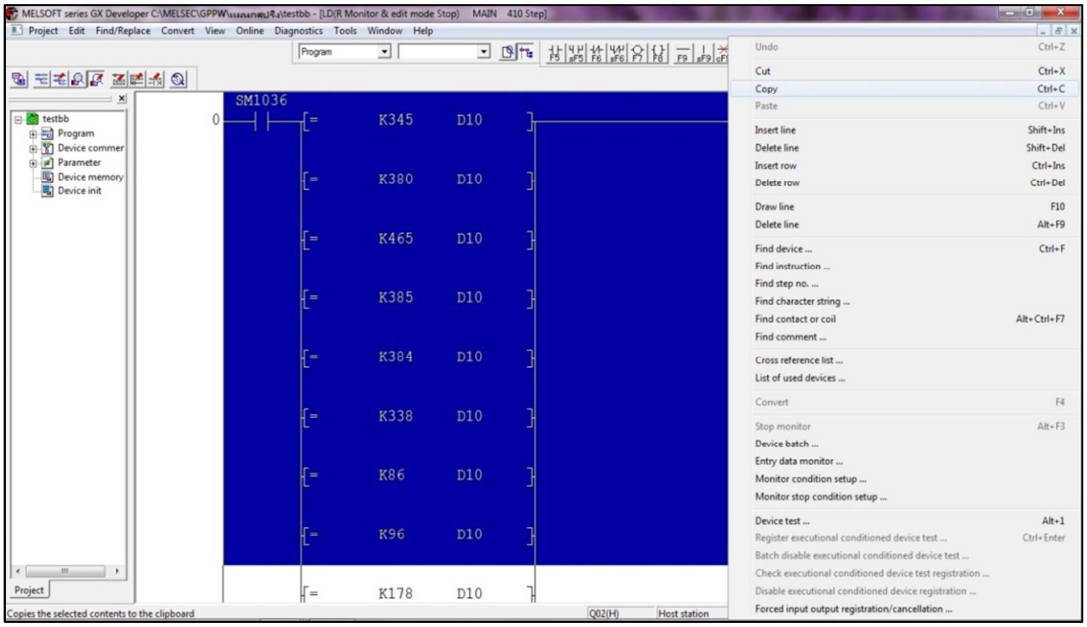


Figure 4.25 Step 3 (copy and paste)

Open the designed program, then left click and drag to blue cover. Next right click and select ‘copy’ command as demonstrated in Figure 4.25.

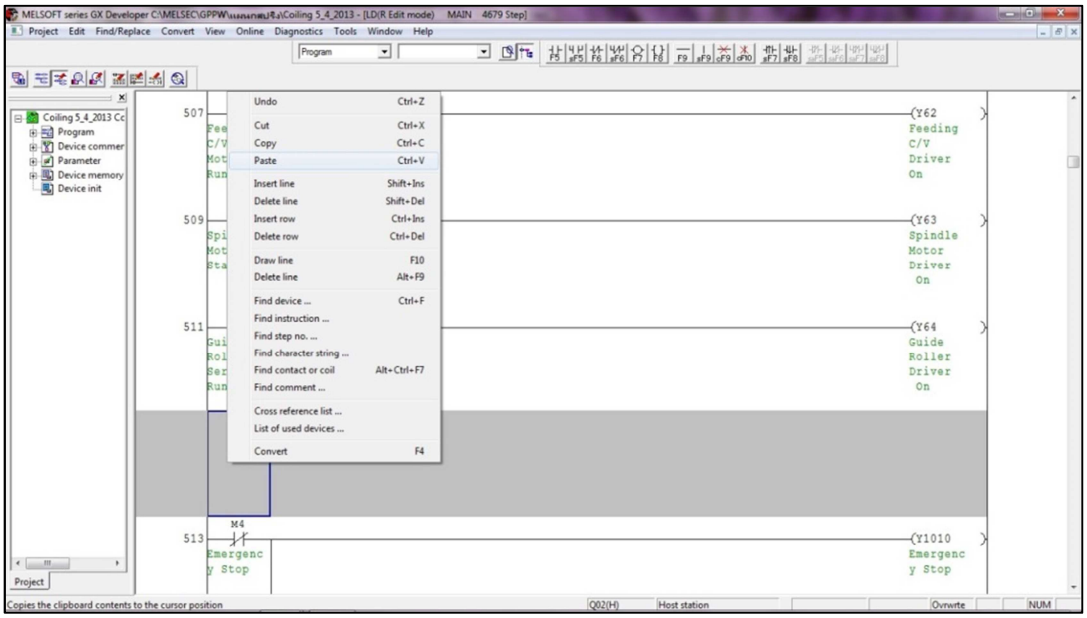


Figure 4.26 Step 4 (copy and paste)

After that, back to primary program and right click on the space to insert ladder and select ‘paste’ command.

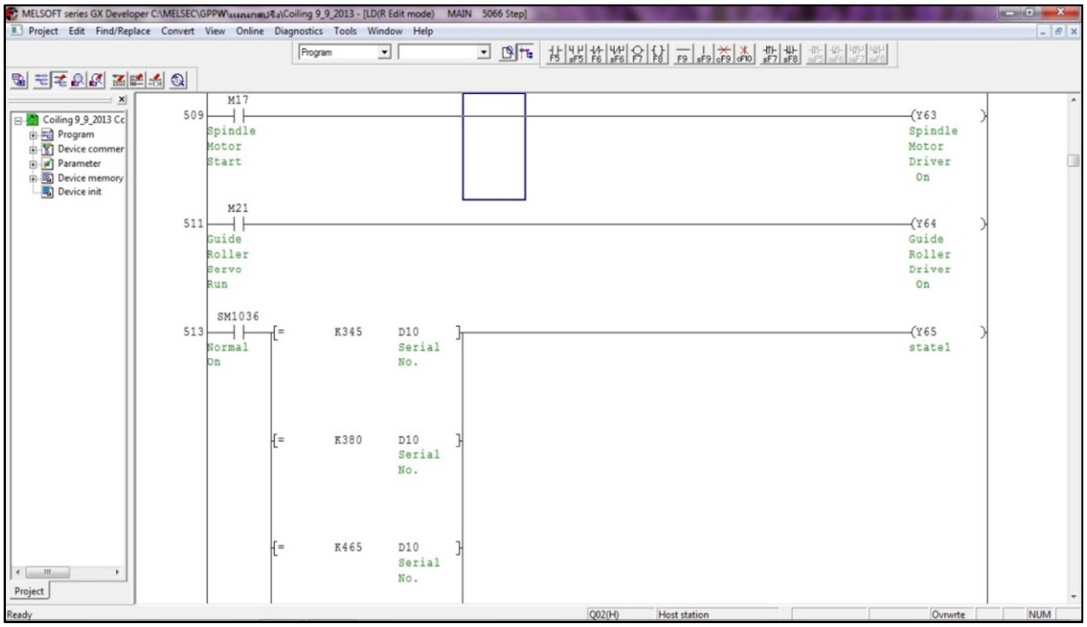


Figure 4.27 Step 5 (copy and paste)

In Figure 4.27, the program was already inserted.

4.8 The overall view of testing

The overall view of testing was conducted by entering the input on Touchscreen to display the output on Interface board. Then the results were compared to the data in Table 4.2 if they were concordant.

Figure 4.28 Entering part number 380 on Touchscreen

Figure 4.29 The results after entering part number 380

Figure 4.28 showed how to enter part number on Touchscreen. (Enter part number 380) while Figure 4.29 illustrated the results after entering part number 380 and comparing with Table 4.2 and Table 4.3 which were the same with the model.

According to Figure 4.30 and Figure 4.31, Ladder Program in PLC could be checked and displayed after entering the Input 380 or D10 = 380 and the operated Output Y65 and Y66. Then the results were compared to Table 4.2 BCD = 000011 which were consistent with Table 4.1.

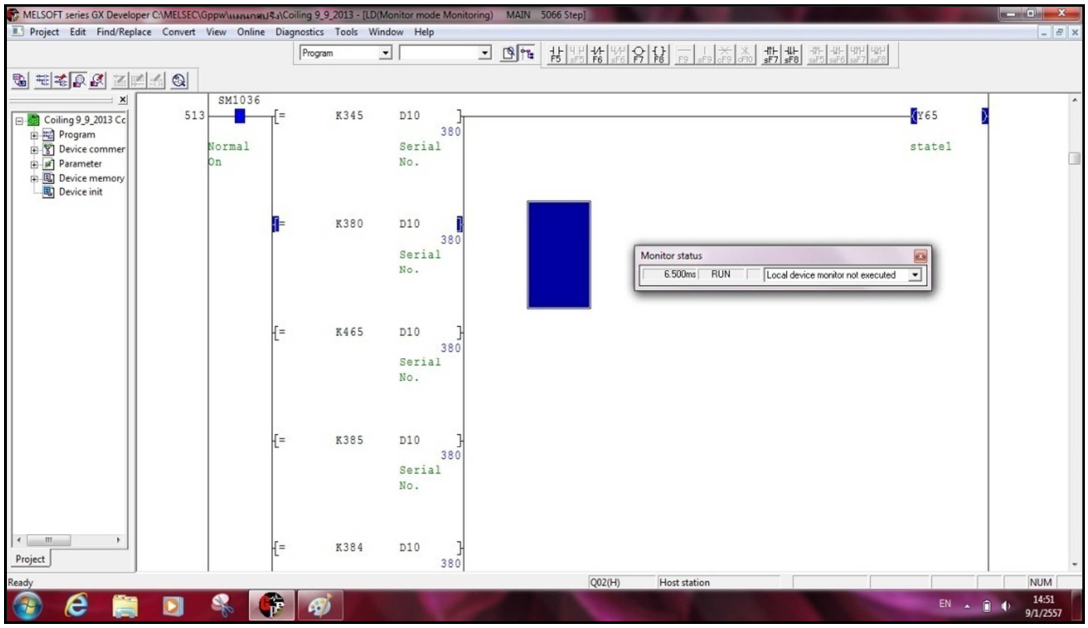


Figure 4.30 Ladder diagram showing operated Y65

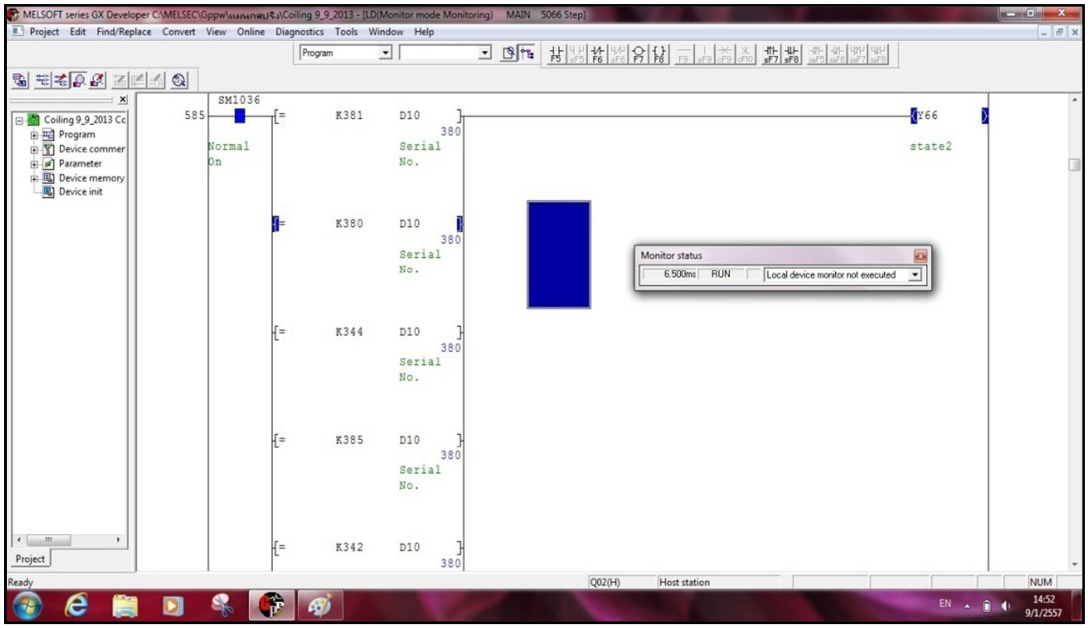


Figure 4.31 Ladder diagram presenting operated Y66

Similarly, Input from 380 was changed to 465. Figure 4.32 presented how to enter part number on Touchscreen. (Enter part number 465) and Figure 4.33 described the results after entering part number 465. Next, the results were inspected with Table 4.1 and Table 4.2. which were concordant with the model.

Figure 4.32 Entering part number 465 on Touchscreen

Figure 4.33 The results after entering part number 465

Figure 4.34 and 4.35 represented the checking methods of Ladder Program in PLC which appeared after entering Input 465 or D10 = 465, and the Output Y65 and Y66 were operated. Then the results were compared to Table 2 BCD = 000011 which was similar to Table 4.2.

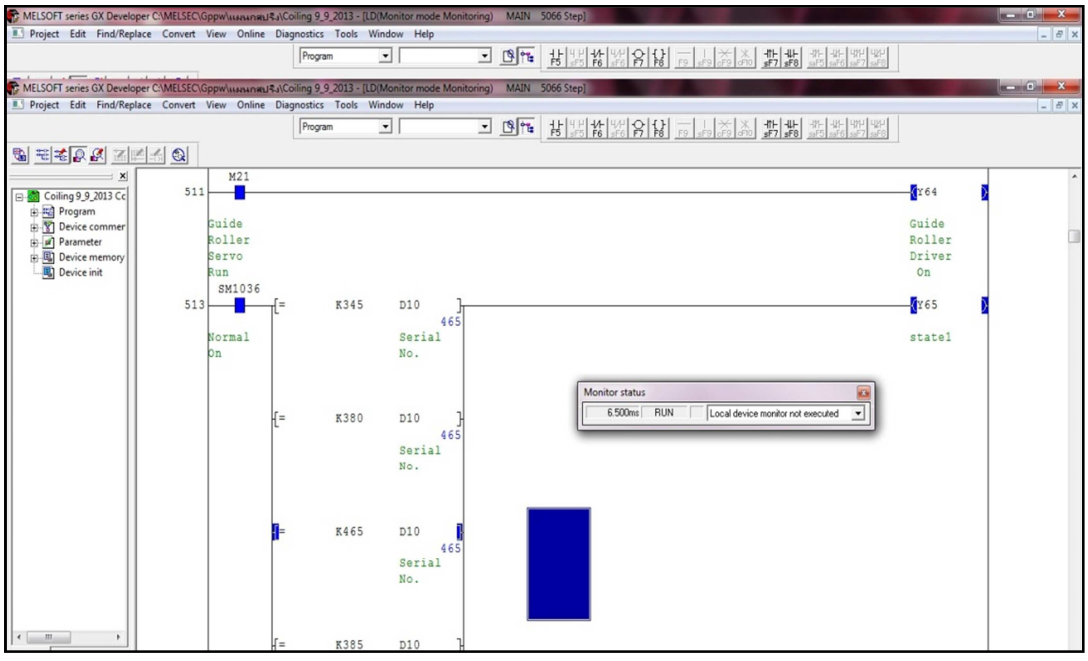


Figure 4.34 Ladder diagram showing operated Y65 (tested again)

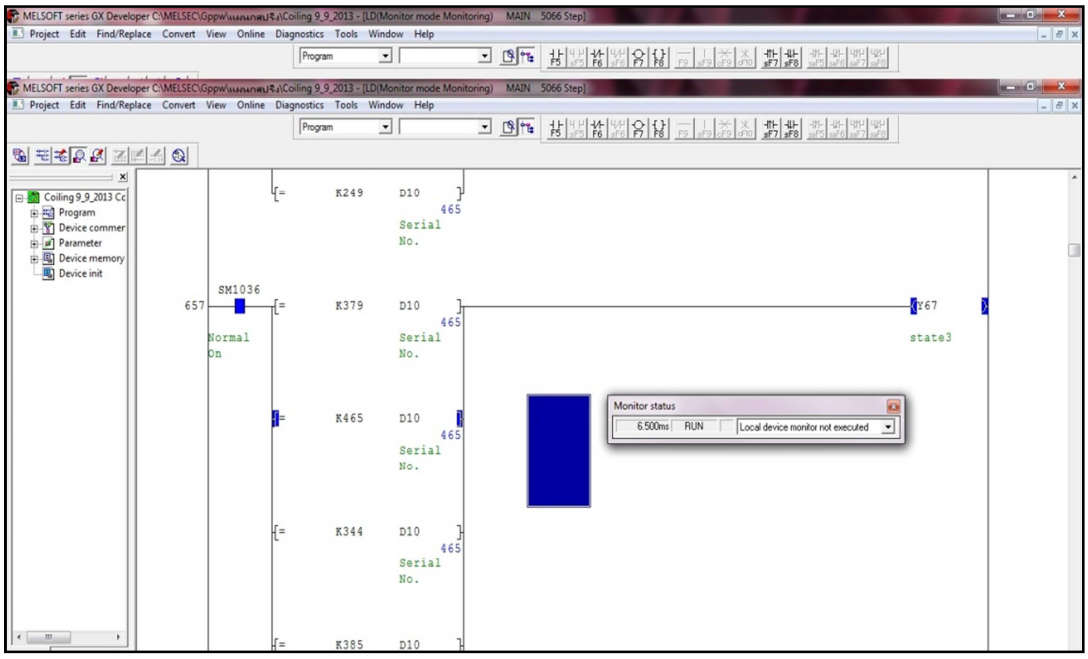


Figure 4.35 Ladder diagram showing operated Y67 (tested again)

Regarding the kit testing, the data in Table 4.2 were used to design the ladder program for PLC use. Consequently, the kit was useful to design the program for the tested device. The test was conducted by changing the output from PLC to BCD before the installation. The results of output were correct and appropriate to install the device in industrial area. Also, it was suitable for the wiring circuit equipped with the devices. The ‘copy’ and ‘paste’ commands could be used to test the program with the kit which helped reduce time for rewriting the program.

CHAPTER 5 CONCLUSION

5.1 Conclusion

The PLC kit was built to test the devices as mentioned above. According to the experiment, the PLC kit could be used to design the circuit of PLC and test the program. The findings were consistent with the designed program. Therefore, there was no any problem with the program installed in the system. It also met the requirements of real work and saved time for designing new program. The PLC kit was not only utilized for testing BCD output, but also other devices such as motor, solenoid or other loads receiving digital outputs. However, there were some disadvantages of this PLC kit. Firstly, it was suitable for PLC of Mitsubishi only. Next, the operation of PLC kit was similar to an electrical system and an automation system. Despite these difficulties, it was helpful for practical use because it could increase working skills for the automation system.

5.2 Future work

Further improvements of PLC kit should be conducted in future researches. For instance, the design of structure should be smaller for easier transport. Also, functions of module operation should be more developed because module of output was only used in this study. Additional modules were interesting for the future paper as well to help increase the efficiency, for example, servo-motor, temperature and flow rate measurement.

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