Research on the Application of PLC in the Electrical Automation Control

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Abstract — The purpose of this study is to analysis and research the application of PLC technology in electrical automation control. Through the design of different experiments, we study the effect of PLC in the switching control, sequence control, numerical control and closed-loop control. We designed a total of 6 small experiments, among them, the first, second and third can reflect the role of PLC in the control of the switch quantity and sequence control, and the fourth and fifth illustrate the role of PLC in the closed-loop control, and the fifth and sixth experiments can reflect the role of PLC in numerical control and frequency converter. Through this study, we can conclude that in electrical automation control, PLC is a very promising monitoring technology, which has great application in the positive inversion of the motor logic control, numerical control, closed-loop control.

Keywords- PLC; Electrical automation control; Programmable controller

I. INTRODUCTION

Electrical automation technology is a comprehensive technology which uses computer technology, information technology [1], instrumentation and control theory to control, manage and optimize the whole industrial production process to improve production efficiency, improve reliability and safety, reduce cost and improve product quality [2]. And to achieve electrical automation technology requires the corresponding electrical automation software, hardware and system [3]. The application of industrial configuration software and field bus control technology are the trend of programmable logic controller in recent years [4].

Programmable logic controller is also simply called PLC, it is recognized as the three pillars of modern industrial automation with the robot and CAD/CAM and PLC is the first of the three pillars [5-6]. PLC is actually a small computer, through the software can be programmed to accept the input signal and control the output signal so as to achieve industrial control through the operation of the program PLC [7]. The internal hardware structure of PLC is almost the same as the computer, which is composed of CPU processor, memory unit, input and output interface circuit [8]. The CPU processor is used to run the program that we write, its memory can be divided into ROM with power saving function and random memory RAM, where ROM is used to save the program, and RAM is used to program the processing procedure [9]. The input and output interface circuit is a bridge between the PLC and the external device. It is responsible for transmitting the external signal to the PLC and outputting the control signal to the controlled device [10].

In the field of modern electrical automation research and development and manufacturing, the application of PLC control technology is becoming more and more widely and plays an important role [11-12]. Compared with the traditional electrical control device, the application of PLC control technology is based on the microprocessor, and the advantages of automatic control technology, computer technology, relay control technology, communication technology, which effectively promote the continuous development of its application areas.

II. RESEARCH

A. Working Principle of PLC

Simply to say that PLC is a computer in truly, this kind of computer is suitable for industrial production control, PLC is mainly composed of a power supply system, CPU, program memory, interface circuit, function module and communication module. The working principle of PLC can be divided into three points. (1) Input sampling link: In this stage, the programmable controller is used to read the data of the sample is the use of a scanning method, and in the input / output of the image of the region of the corresponding module to store data. After the input of the sample data, so that the user can continue to carry out the program to the user to enable the operation to achieve refresh. At this stage, if the input data has changed, then in the input / output in the region of image processing module to receive the data is not changed. Therefore, if pulse signal input, the signal is than the width of a scan cycle to many, only in this way before they can ensure that in all possible cases data can be read. (2) User program execution link: In this link, In the user program, the programmable controller is used to read the data of the sample, which is the use of a scanning method, and in the input / output of the region of the image processing module to receive the data is not changed. Therefore, if pulse signal input, the signal is than the width of a scan cycle to many, only in this way before they can ensure that in all possible cases data can be read. (2) User program execution link: In this link, In the user program, the programmable controller is used to scan the implementation of the program. The algorithm is implemented by the same route and process. At the same time, the steps are also from left to right. The final result of the operation is to be performed, and the result is to refresh the action in the case of the logical coil in the storage area, and the input / output image area. (3) Output
refresh link: In this link, the CPU system will be strictly according to the data in the image area, all of the output latch circuit to refresh, and then the output latch circuit input to the corresponding circuit driver PLC.

B. Three Phase Asynchronous Motor Control (based on the relay contactor)

The main content of the experiment is to control the positive inversion of three-phase asynchronous motor by the lock of the electric control line. The equipment required for the experiment includes keys, relay contactor, three-phase asynchronous motor, power supply and contact wire. Experimental wiring diagram is shown in Figure 2. One of the purposes of the experiment is to allow students to understand what is self-lock, what is the lock, through the connection of the electrical control circuit. In addition, by understanding the motor is reversing the line control mode to do the foundation, you can more clearly understand the PLC logic control motor forward and backward.

Figure 1. The basic composition of PLC

Figure 2. Motor control wiring diagram

C. Three Phase Asynchronous Motor Control Test (based on intelligent motor starter)

Intelligent motor starter will be the traditional on-off control, overload and overcurrent protection functions in a body, and built-in memory function, it can record the motor parameters and running log, and with a variety of communication modules such as CANopen, Modbus, DeviceNet, can achieve communication control.

The experiment used M218 PLC with the Modbus signal communication to take communication control with the intelligent motor starter Tests Writing command register to the motor is reversed and reset function, and read the status register state information and motor current value.

D. Traffic Light Control System based on M218 PLC Test

The purpose of this experiment is to test the role of PLC in the closed loop control, The implementation requirements of traffic light control is when pressing the start button, the north and south green light put out after lighting 6s, then north-south yellow light put out after the bright 1s, the red light is bright on 5s, cycle in accordance with the above order. Corresponds to the north and south direction of the green yellow red light, the East and west of the red light put after lighting 6s, the yellow light was bright for 1s, and the green light put out after lighting 5s, cycle in accordance with the above order. In order to meet the requirements, using the ladder diagram language design, while the use of the timer instruction logic function programming.

E. Design of two kinds of Hybrid Control System based on PLC M218

Liquid mixing is a device for mixing two liquids in a certain proportion, the basic structure diagram is shown in Figure 3 below. This experiment through the design of line and connection line to achieve the basic functions.
experiment aims to achieve the following requirements: when you press the start button, the solenoid valve Y1, the first solution A is injected into the container; when the liquid level reaches L2, the solenoid valve is Y1, and the solenoid valve Y2 is connected to the B, and the first liquid is injected into the A, when the mixer reaches the present time, the mixer stops stirring, at the same time on the discharge of the solenoid valve Y3, when the liquid level position to reach L3, close the discharge solenoid valve, a working cycle is over.

Figure 3. Solution mixing operation principle diagram

F. Inverter Multi Section Speed Control Test

Test content is given by the PLC remote control frequency converter. Experimental wiring diagram is shown in Figure 4.

Figure 4. Experimental wiring diagram

G. PLC inverter communication experiment

PLC is a common technology for remote control and control of inverter by serial bus. Through the Modbus communication connected the PLC M218 serial port 2 to the inverter ATV312, set the working mode of ATV312 for remote control, through the M218 programming to achieve its ATV312 start and stop and speed control. M218 built two standard RS485 serial port: COM1 and COM2, COM1 used in the communication with the touch screen, this experiment uses the COM2 port and frequency converter, the converter terminal interface type is RJ45, the wiring diagram is shown in Figure 5.

Figure 5. Serial port connection diagram

And the frequency converter working mode is set up in Table 1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Parameter description</th>
<th>Parameter values</th>
<th>Parameter value function description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTL-LAC</td>
<td>Function access level</td>
<td>L3</td>
<td>Access to advanced features and hybrid control mode management</td>
</tr>
<tr>
<td>CTL-FR1</td>
<td>Configuration given 1</td>
<td>ndb</td>
<td>Through the Modbus given</td>
</tr>
<tr>
<td>CTL-CHCF</td>
<td>Control mode settings</td>
<td>SIN</td>
<td>If LAC=L3 can access the parameter: SIN - combination, control and frequency are given by the same way; SEP - separation, control, and frequency are given in different ways</td>
</tr>
</tbody>
</table>

The program of writing the PLC control as shown in Figure 6. The function of the function block IsFirstMastCycle is the output of a TRUE signal after the first MAST task cycle. The signal is used to read and write functions, and then read and write functions will be implemented through the Start variable cycle. Function block ADDM can be Modbus from the device address to read and write module can identify the address information, which means that the Modbus second communication port and the label is 1. Function block READ_VAR and WRITE_VAR are respectively read and write operations on the internal registers of the converter. The function reads
the address 3201 and 3202 of the data stored in the array Read_Data, the array Write_Data data will be written into the address of 8501 and 8502 of the register. Function block DriveCom_ATV312 is a custom function, you can set the state of the inverter is set to standby operation, and when the operation command and frequency to receive the timing of the command word and frequency output to the array Write_Data.

![Figure 6. PLC control program](image)

**Figure 6. PLC control program**

System online debugging results are shown in Figure 7. Here to the inverter 5Hz is to do a case of online debugging.

![Figure 7. System online debug map](image)

**Figure 7. System online debug map**

### III. ANALYSIS

Through experiment 1 and experiment 2, we can find that PLC has the ability to "and", "or", "non" and other logical operations, can realize the logic operation, with the contact and circuit of the series, parallel, instead of the relay combination logic control, timing control and sequential logic control.

Experiment 3 shows the application of PLC in transportation system. PLC technology has a strong adaptability to the environment, in which the timer resources are very many, so it can control the traffic lights, especially to control the multi forkPLC technology also has the role of communication and networking, the use of programming control to the implementation of the signal lamp without the control, and can be put on a road signal lamp is a local area network, and then the implementation of centralized control, so that the vehicle in the course of the time to be short. PLC technology has the function of the upper computer interface and the clock. It is able to receive data from the host computer and can also use the software, intelligent management of the studio lights and fog lights. Moreover, the PLC technology has a lot of decoding command, to the data received from the seven segments of the display code, and then transferred to the LED digital tube to display data. Using PLC technology as the main engine and the development of the lane control machine is in a wide range, and it is better to maintain. Its useful life and reliability are also significantly improved

The results of the experiments 4 and 5 show that the application of the automatic startup program can make the PLC of the sequence of modules to accumulate running time of the main equipment selection, and automatically determine the starting and closing of the device according to the length of the run time. It also can cooperate with the conventional control system to be the main control mode of power automation system. The conventional control system can be used as a supplement to PLC, when PLC occurs faults, the conventional control system can ensure the equipment to continue to work, improve the reliability of the system.

As for experiment 6, it proves the important role of PLC in numerical control. According to the different control modes, the CNC system can be divided into the control system, the continuous control system and the linear control system. PLC is an automatic control system for industrial automation. In the numerical control system, the position of the moving parts can be accurately located. In addition, it is also capable of accurate calculation of the use of the components.

### IV. CONCLUSION

In summary, in electrical automation control, PLC is a very promising technology. It overcomes many shortcomings of the traditional electrical automation control system, and in a certain extent, it improves the work efficiency. We can draw the conclusions from the results of the experiments that PLC technology has different functions in different control systems, but whether in the order of control, or in the closed
loop control or numerical control, it has played a very important role which cannot be ignored.

REFERENCES