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# *Design of Temperature Remote Control System Based on S7-200 PLC*

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***Abstract:*** A remote control solution based on cloud configuration is proposed to address the problem of long distance between development and site in industrial control processes, which requires technicians to solve problems on site in case of faults. The solution uses S7-200 PLC as the control authority and semiconductor chips as the executing mechanism to design a temperature control system. Through cloud configuration, the observation of on-site status and remote modification of control strategies are achieved, which effectively solves the spatial distance problem between development and on-site applications. The experimental results prove the effectiveness of the solution.

## 1. Introduction

Industrial process control is an indispensable part of modern industrial production. It uses various technologies and equipment to automatically monitor, control, and optimize industrial production processes, aiming to improve production efficiency, reduce production costs, enhance product quality, ensure production safety, and achieve sustainable development. Through the application of automation systems, unmanned or less - manned operation of the production process can be realized, reducing the influence of human factors on the production process.

However, in the development process of industrial process control, there are also many problems. When the control system malfunctions, developers usually need to be on-site for diagnosis and troubleshooting. This not only increases the maintenance cost but also may lead to production interruption and affect production efficiency. In addition, for industrial sites that are geographically remote or have harsh environments, the on-site response of technicians may be delayed, further exacerbating the severity of the problem.

The development of remote control technology provides an effective way to solve the above problems. Developers can use network technology to remotely monitor the operating status of the system in real time, quickly respond to fault alarms, troubleshoot and repair, reducing downtime and business impact. Cloud configuration is one of the implementation methods of remote control technology, which uses the cloud computing platform to remotely monitor and manage industrial equipment. The maintenance and update of the cloud configuration system can be carried out through the cloud without on-site operation, reducing the maintenance cost and improving the system's availability.

This paper designs a temperature control system with an S7-200 PLC as the controller. The working time of the semiconductor chip is calculated through the PID algorithm to achieve precise temperature control. The on-site status observation and remote modification of the control strategy are realized through the Aimosen gateway device and its cloud configuration.

## 2. System Hardware Composition

The hardware part of the temperature remote control system based on S7-200 PLC consists of three major parts: S7-200 PLC, temperature sensor and transmitter, semiconductor cooling chip and its driver, and cloud gateway module.

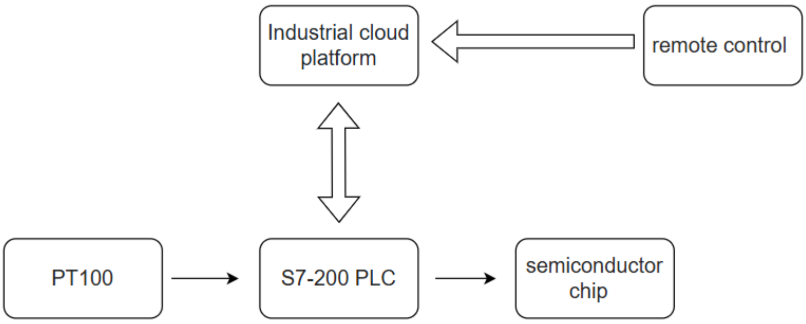


*Figure 1 Hardware Composition Block Diagram*

The temperature sensor part uses a PT-100 platinum thermal resistance sensor to collect temperature data. This sensor is a three-wire type with a standardized interface and output signal. When the temperature changes between 0 and 100 degrees Celsius, the maximum non-linear deviation is less than 0.5 degrees Celsius. The platinum resistor has excellent long-term stability, enabling the PT-100 temperature sensor to maintain consistent measurement performance during long-term use. In addition, the sensor also has good vibration and shock resistance, making it suitable for harsh working environments.


*Figure 2 PT100 Temperature Sensor* *Figure 3 Semiconductor Cooling Chip*

The temperature control system consists of a 12V power supply, a semiconductor cooling chip, a relay, and a cooling fan. The 12V power supply can provide voltage for the semiconductor chip and the fan. The duty cycle wave of the PWM is calculated through the PID algorithm to control the opening and closing of the relay, thereby achieving the purpose of controlling the refrigeration power of the semiconductor chip. Semiconductor refrigeration, also known as electronic refrigeration or thermoelectric refrigeration, is a discipline developed in the 1950s at the edge of refrigeration technology and semiconductor technology. It uses P-N junctions composed of special semiconductor materials to form thermocouple pairs, generating the Peltier effect, that is, a new type of refrigeration method that uses direct current for refrigeration. It is known as one of the three major refrigeration methods in the world together with compression refrigeration and absorption refrigeration.


*Figure 4 Aimosen Gateway Module*

The remote control system uses Aimosen's IOT-PG200S to realize the function of the cloud gateway. On the PC side, a virtual network card is created through Aimosen software to connect to this cloud gateway module, realizing the functions of remotely viewing, modifying, uploading, and downloading PLC programs. At the same time, the IOT-PG200S has the function of collecting PLC data and uploading it to the cloud. By accessing the PLC memory address, the data is encrypted and uploaded to the cloud to realize the cloud configuration function. Users can set the cloud configuration interface through programming software to achieve the function of remotely viewing and controlling PLC data.

## 3. Precise Temperature Control Method

The operation of the semiconductor cooling chip uses direct current. It can be used for both refrigeration and heating. By changing the polarity of the direct current, refrigeration or heating can be realized on the same cooling chip. It consists of two ceramic sheets, with N-type and P-type semiconductor materials (bismuth telluride) in the middle, connected in series in the circuit.

The working principle of the semiconductor cooling chip is as follows: When an N-type semiconductor material and a P-type semiconductor material are connected to form an electrical couple, after connecting direct current in this circuit, energy transfer can occur. The junction where the current flows from the N-type element to the P-type element absorbs heat and becomes the cold end, while the junction where the current flows from the P-type element to the N-type element releases heat and becomes the hot end.

Simply using Bang-Bang control will result in a large steady-state error, which is not conducive to precise temperature control. Therefore, the PID control algorithm is adopted to calculate the pulse width of the PWM PULSE to control the operation of the semiconductor chip and achieve precise temperature control.

In the Step7 development environment, the PID sub-function and PWM sub-function are configured and called using the wizard. Hardware-wise, the S7-200 PLC is connected to the EM235 module. In the PID sub-function, the PV-I input value is set to the analog data collected by the PT100 temperature sensor, and the Setpoint is set to the desired temperature. The output calculated by the PID is given to the duty cycle of the PWM wave. The PWM wave is output to the control relay of the semiconductor cooling chip, and the relay is connected to the semiconductor chip, thereby achieving the purpose of controlling the power of the semiconductor chip.

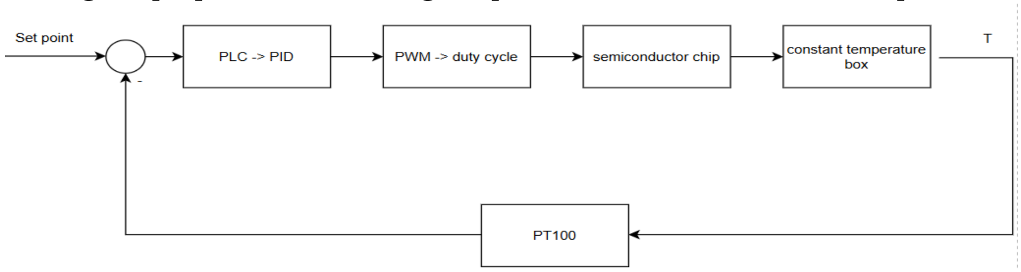


*Figure 5 Flowchart of Precise Temperature Control Method*

## 4. Cloud Configuration

The Aimosen AMX-I0T-PG200S is an industrial Internet of Things data collection gateway responsible for connecting PLC devices, collecting, and transmitting data to the Aimosen Cloud Industrial Internet of Things platform. To realize the functions of remote uploading and downloading of PLC and cloud configuration, it is necessary to download the AIOT_WORKS software to debug the cloud gateway module.

First, the AMX-I0T-PG200S cloud gateway device should be correctly wired. This module uses the RS485 protocol to connect to the S7-200 PLC. Connect the 3rd pin of the RS485 protocol solderless head to port A of the cloud gateway module, and the 8th pin to port B of the cloud gateway module. Connect the computer to the cloud gateway device with a network cable, and configure the IP address of the local network card to be in the same network segment as the cloud gateway device through the control panel. Open a browser, enter the default IP address of the device in the address bar, and enter the device parameter modification page. Enter the name and password of the connected hotspot in the WIFI configuration column. After resetting, the network cable must be connected to perform the above operations; otherwise, the cloud gateway device cannot be used normally.


*Figure 6 Webpage Configuration of Cloud Gateway*

Open the AIOT_WORKS software, create an account and password to enter the software page. Select device management in the left navigation bar to enter the device management page. In the device management interface, add a new device, and enter the corresponding serial number of the device to start the configuration of the device functions. Select serial port bridging in the page, select Siemens PPI for the PLC model, and click bridge. If the bridging log below shows a successful bridging prompt and the page shows that it is bridged, the device is successfully bridged.
Associate the cloud collection function of the temperature control system with the cloud configuration function. In this page, add a new device in the serial port 1 option and modify the serial port parameters. Select and modify the model of the connected PLC, baud rate, parity method, and other parameters. After clicking OK, correctly set the name of the variable to be read, the register address, and the PLC slave address on the right page, so that the AMX-I0T-PG200S cloud gateway device can correctly read the internal temperature data of the PLC.

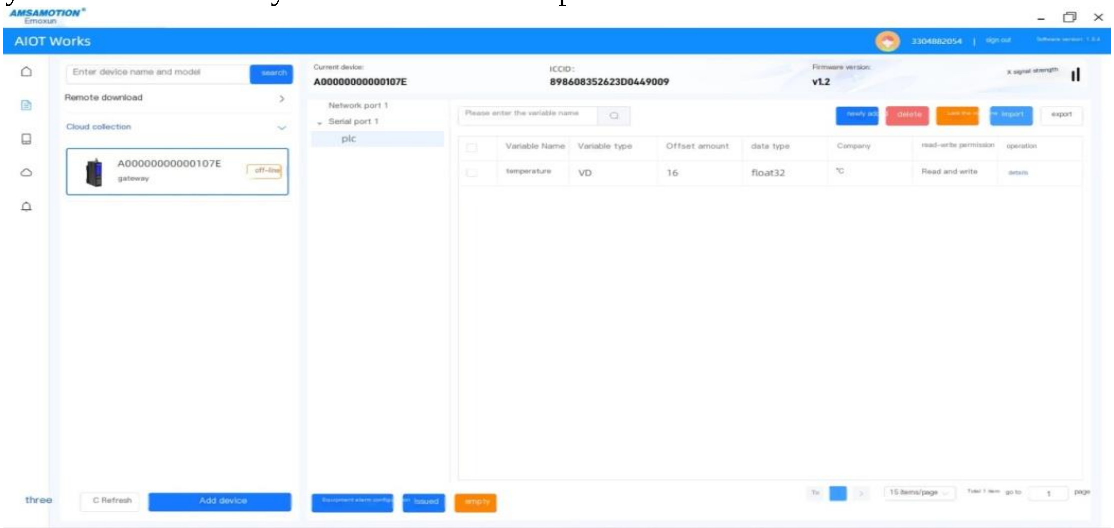


*Figure 7 Cloud Collection and Variable Setting*

The cloud configuration page can also be used to draw the on-site control interface. Select cloud configuration in the left navigation bar, add a new configuration in the cloud configuration list, and click to enter the configuration page for drawing. Draw the cloud configuration interface according to requirements at the given website. When using some components, bind the variables set in the cloud collection function. After the page drawing is completed, click run to realize the remote data viewing and control of the PLC.

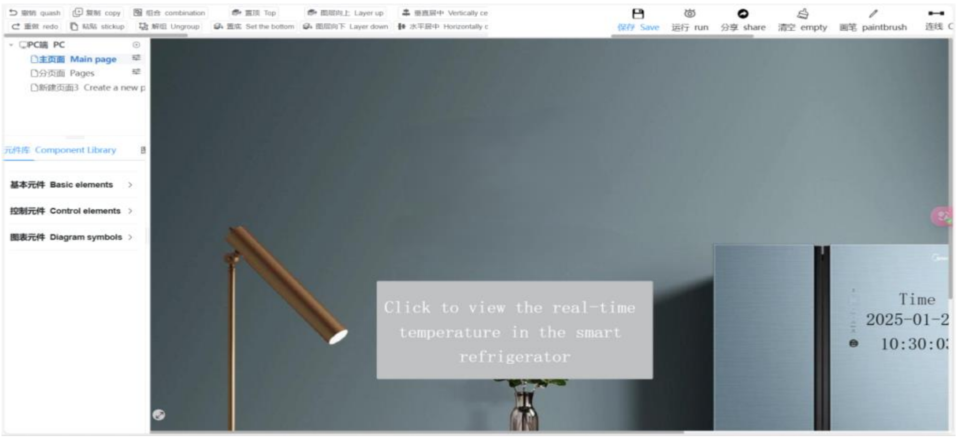


*Figure 8 Cloud Configuration Design Page*

## 5. Experimental Process

Correctly wire the temperature remote control system based on S7-200 PLC and power it on. At the same time, use the AIOT-WORKS software to bridge the IOT-PG200S cloud gateway module with the PC side to realize the functions of remote uploading, downloading, and debugging of the PLC program. Click to run the program and disconnect the software bridge at the same time. The semiconductor chip, as the actuator, starts to work, and the internal temperature of the controlled object is controlled within the specified temperature range, with the steady-state error controlled within 2%.

At the same time, open the AIOT-WORKS software, enter the cloud configuration design page, configure the pre-designed internal components and variables of the cloud configuration, and click to run the cloud configuration to view the real-time temperature of the temperature control system.

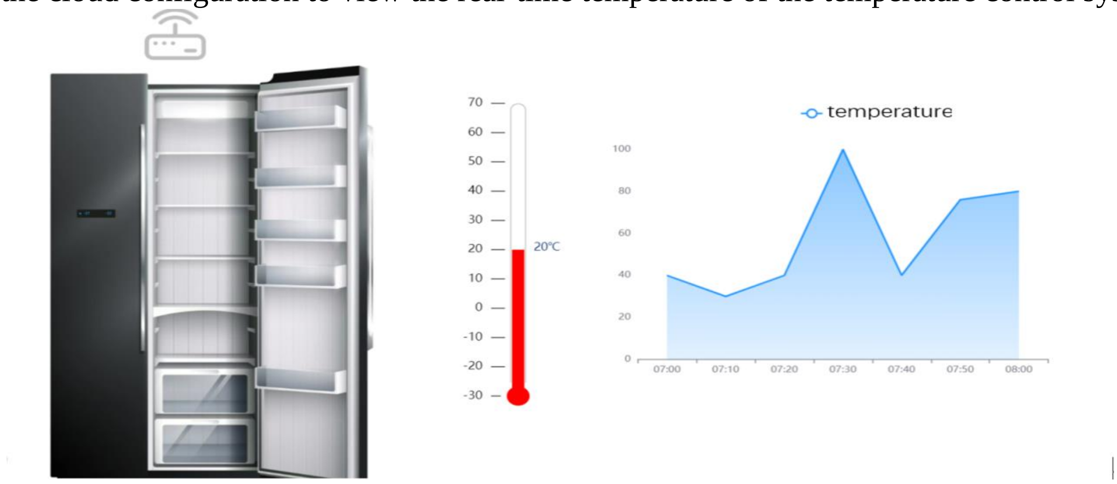


*Figure 9 Cloud Configuration Page*

## 6. Conclusion

The temperature remote control system based on S7-200 PLC realizes remote configuration and control through the communication among the cloud platform, Internet of Things devices, and user terminals, completing the information transfer between smart devices and the cloud platform, as well as between the cloud platform and user terminals. In addition, this design uses a semiconductor chip as the actuator to design a temperature control system and adopts the PID control algorithm to achieve precise temperature control.

The remote control solution based on the cloud platform can be applied to a variety of different application scenarios. For example, it can be applied to the smart agriculture Internet of Things cloud platform to uniformly manage and monitor agricultural automation production equipment, changing the traditional agricultural production mode; or it can be applied to the cloud-based smart home control system to realize remote control of various electrical switches at home and collect home environmental information such as gas, natural gas, smoke, illuminance, temperature, and humidity.

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