A Converter Station Area Temperature Acquisition System Based on Bluetooth Transmission

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Abstract. Due to excessive noise at the converter station, it disturbs the normal life of the residents nearby, the power supply company installed the noise barrier at the wall of the converter station. After installing the noise barrier, the equipment in converter station is always in a high temperature operation environment, especially the control cabinet in the converter transformer region. The temperature acquisition system based on Bluetooth transmission is designed and developed to collect the temperature data in the control cabinet and different areas of converter, and to analyse the temperature trend in different areas. In this paper, a Bluetooth-based temperature acquisition system architecture and system workflow are introduced. Installation tests are carried out at the upper, middle and lower positions of the secondary control cabinet and inside and outside the converter rheological barrier at the converter station. The test results show that the system is easy to install and read historical data. Operating and maintenance personnel revise the temperature threshold under overload operation according to the temperature distribution, which is convenient for operation and maintenance personnel to focus on inspection. At the same time, it accumulates effective basic data for environmental management of secondary control cabinet.

1. Introduction

At present, DC converter stations that have been put into operation are often subject to excessive noise complaints from nearby residents, affecting the normal life of residents [1]. In many areas, power supply companies have installed sound insulation barriers on the walls of the converter station to solve the problem of noise disturbance [2].

A converter station in Guangzhou has installed noise barriers to solve the problem of noise disturbance. However, Guangzhou is located on the subtropical coast and belongs to the maritime subtropical monsoon climate. It is characterized by warm and rainy weather, abundant light and heat and long summer. On the basis of high ambient temperature and heat dissipation of the heat exchanger of the converter transformer, and surrounded by a layer of noise barrier, the converter transformer area equipment is in a high temperature operating environment for a long time. This is a test for the operation of the equipment, especially the operation of the secondary equipment in the control panel. The temperature change is slow. Therefore, an offline environment acquisition system for the converter station area based on Bluetooth transmission is installed in the secondary control cabinet of the converter

station, which is convenient for the operation and maintenance personnel to intuitively grasp the temperature change trend of the secondary panel area during the inspection.

The confidentiality requirements of the power grid data are high. The data collected in the station is collected by the operation and maintenance personnel into the mobile phone APP through Bluetooth, and exported to the Industrial Personal Computer through Excel for statistical analysis. Analysis within the station's data station to ensure data transmission security.

2. System Architecture

The offline environment system of the converter station area based on Bluetooth transmission is shown in Figure 1. The CPU of the ARM core is used for temperature acquisition. The system power is not more than 100w, and the system power supply AC220V is used to fully meet the system operation requirements, and at the same time ensure the safety of electricity consumption.

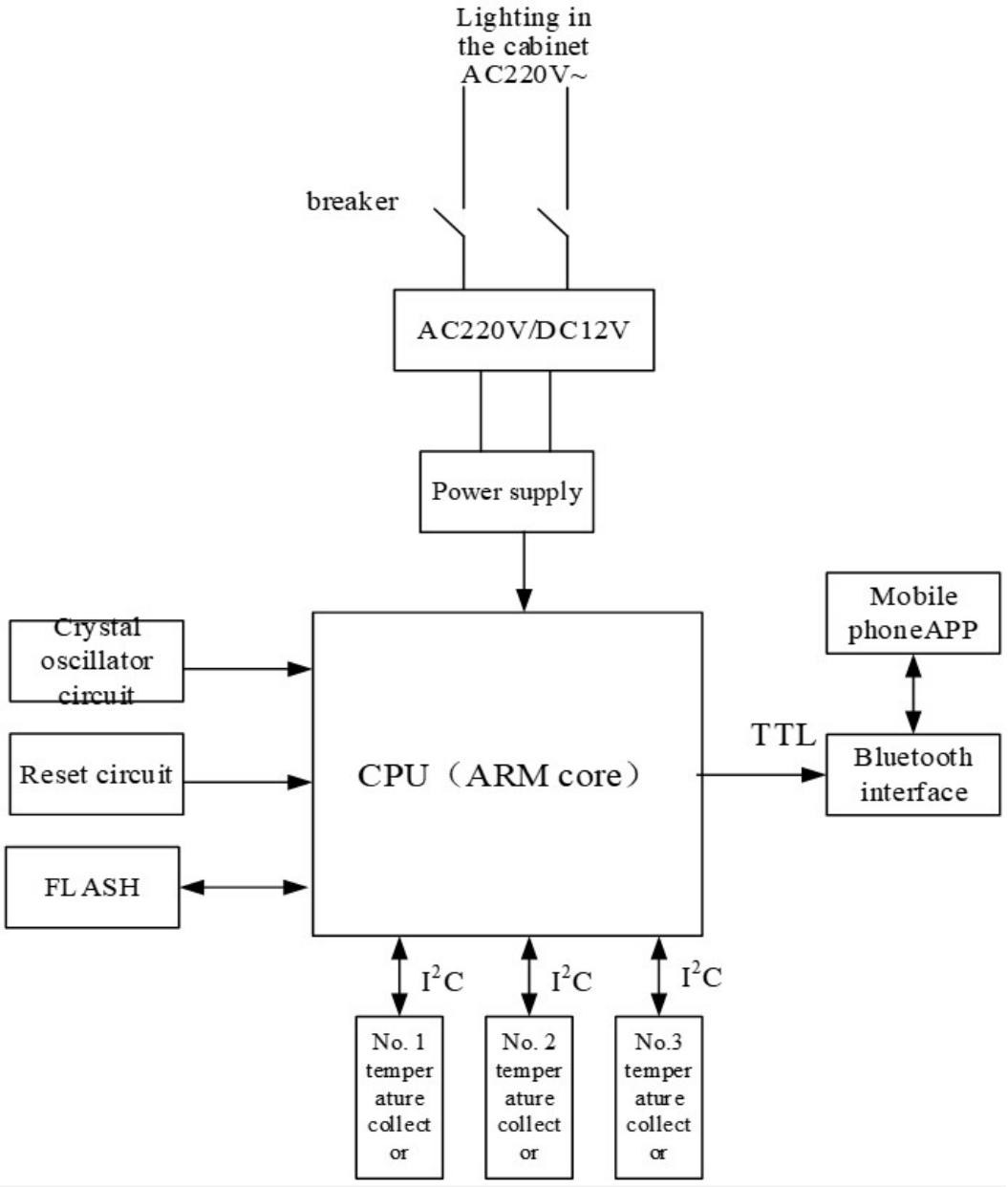

Figure 1. System architecture

2.1. Master CPU circuit

The main control CPU adopts ARM core MCU STM32F103C8T6. The maximum operating frequency of the MCU is 72MHz. It can reach 1.25DMips/MHz when the memory is waiting for 0 cycles. It has IIC and UART/USART interface devices to meet the system requirements.

2.2. Temperature and humidity acquisition sensor and circuit

The temperature and humidity acquisition sensor adopts SHT20 digital temperature and humidity sensor. The SHT20 has high reliability and excellent long-term stability. It has full-scale calibration and two-wire digital interface, which can be directly connected to the single-chip microcomputer. In addition, SHT20 is small in size, fast in response, low in energy consumption, immersible, strong in anti-interference ability, integrated in temperature and humidity, and has dew point measurement.

Table 1. The technical target of SHT20

No.	parameter name	Technical indicators
1.	Humidity measurement range	0~100%RH
2.	Humidity measurement accuracy	±3%RH
3.	Temperature measurement range	-40~125℃
4.	Temperature measurement accuracy	±0.3℃
5.	Operating Voltage	2.1~3.6VDC
6.	Communication Interface	I^2CInterface output

The GPIO of the STM32F103C8T6 microcontroller can be directly connected to the SHT20 pin for IIC communication. As shown in Figure2, the microcontroller and the SHT20 are directly connected to the circuit.

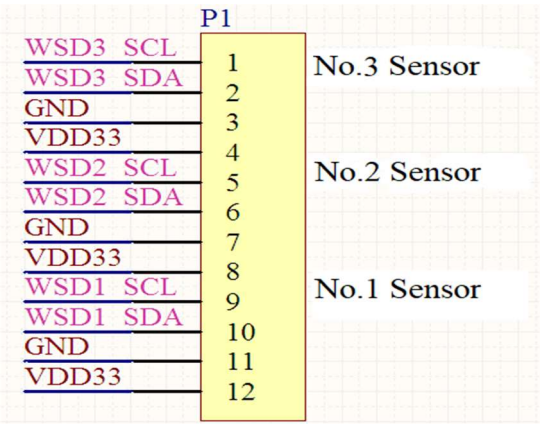

Figure 2. The SHT20 interface circuit

The MCU reads the temperature and humidity of the SHT20 sensor through the IIC interface, and the MCU converts the read data to obtain the collected temperature and humidity data. The conversion formula [3] is as follows:

$$\mathrm{RH\%} = -6 + \frac{125 \times \mathrm{SRH}}{2^{16}}$$

$$\mathrm{T} = -46.85 + \frac{175.72 \times \mathrm{ST}}{2^{16}}$$

Where RH is the humidity value, T is the temperature value, SRH is the humidity signal quantity collected by the IIC interface, and ST is the temperature signal quantity collected by the IIC interface.

2.3. Bluetooth interface transmission circuit

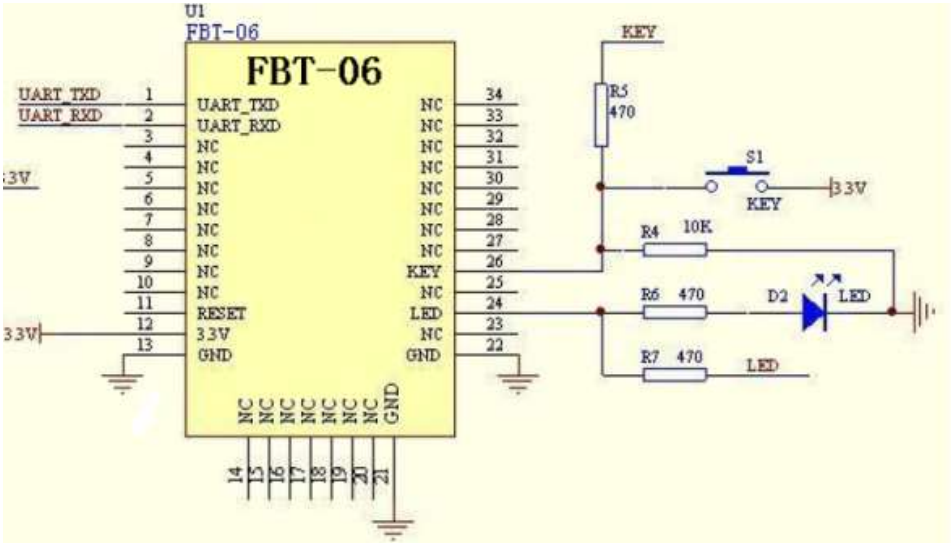

Figure 3. Bluetooth interface circuit

Bluetooth is a short-range wireless communication technology. The transmission distance is generally 10 m. If the transmission power is appropriately increased, the transmission distance can reach more than ten m. Working in the 2.4 GHz open frequency band, transmission in this frequency band will effectively reduce the transmission loss in the converter station, and at the same time have the advantages of penetrating obstacles, point-to-point or point-to-multipoint data transmission [4-5], in the converter station environment suitable for wireless data transmission using Bluetooth technology.

The Bluetooth interface circuit adopts the FBT-06 embedded short-range Bluetooth serial communication module, which complies with the V2.1+EDR Bluetooth specification and has an internal antenna. This module can be directly connected to the STM32F103C8T6 microcontroller serial communication GPIO, as shown in Figure 3.

3. System Work Flow

The system workflow is shown in Figure 4. After the system is connected to the power supply, the power-on single-chip system is initialized. After the microcontroller is initialized, the MCU initializes the Bluetooth module with the AT command. After the Bluetooth module is initialized, the system starts to collect multiple points of temperature and saves it in the external FLASH while waiting for the command of the external Bluetooth transmission. When the mobile phone APP with Bluetooth function is close, the command verification is performed first. After the verification is successful, the system automatically uploads the historical temperature data to the operation and maintenance personnel mobile APP through Bluetooth.

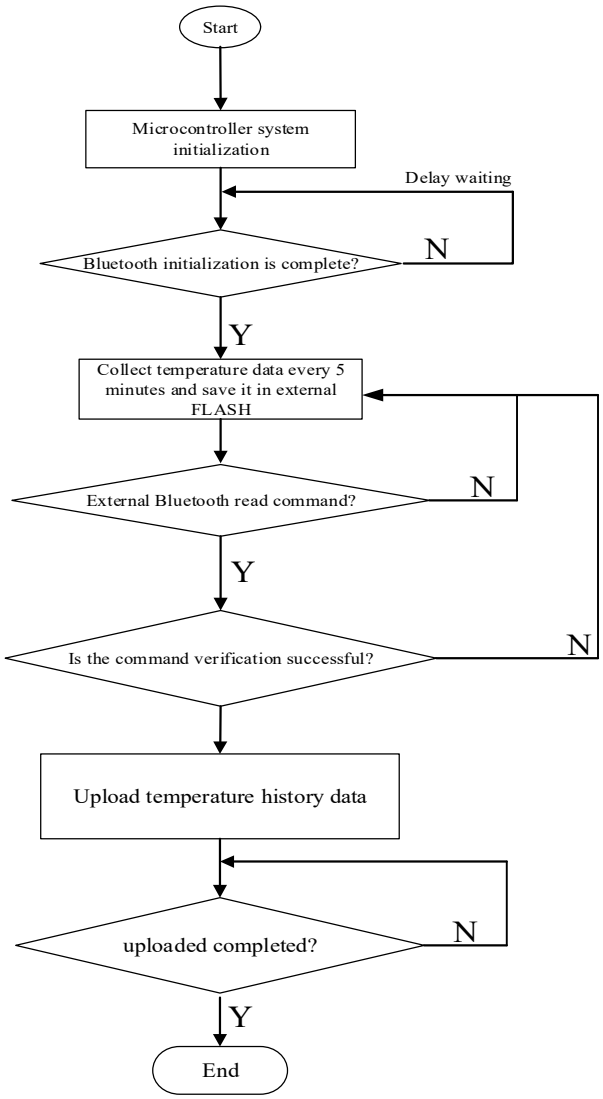

Figure 4. System work flow chat

4. Test verification

4.1. Secondary control cabinet installation test

Select a secondary control cabinet of the converter station for system installation. The dimensions, length, width and height of the secondary screen cabinet are: 1000×370×1800mm, and the secondary control cabinet is shown in Figure5.

Figure 5. Control cabin

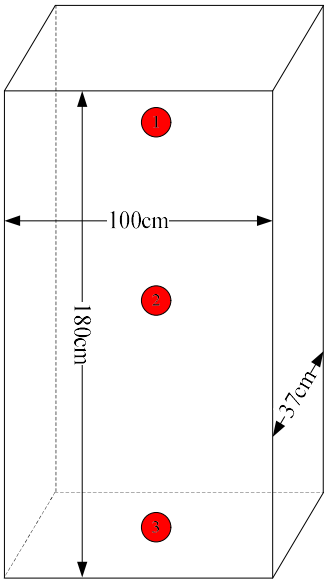

Figure 6. Temperature distribution of control cabinet

The width of the secondary control cabinet is narrow, and the temperature fluctuation of the same plane is not obvious. At the different heights, three temperature measuring points are selected for the temperature data acquisition of the secondary control cabinet area, which are divided into upper, middle and lower, as shown in Fig. 6.

4.2. Regional temperature distribution

In the summer, through the offline acquisition system based on the regional temperature of Bluetooth transmission, the operation and maintenance personnel perform statistical analysis on the temperature data of the secondary control cabinet. The historical data of temperature and humidity derived from Excel are shown in Table 2.

Table 2. Temperature and humidity historical data

Time	Temperature/℃	Humidity/%
2018-08-01 11:05:00	32.1	36.9
2018-08-01 11:10:00	29.9	37.7
2018-08-01 11:15:00	28.9	38.5
2018-08-01 11:20:00	28.2	39.3
2018-08-01 11:25:00	27.8	39.7
2018-08-01 11:30:00	27.5	40.1
2018-08-01 11:35:00	27.2	40.4
2018-08-01 11:40:00	27.0	40.5
2018-08-01 11:45:00	26.9	40.7

Three sensors are installed in the secondary control cabinet to measure the temperature zone distribution of the upper, middle and lower three positions in the secondary control cabinet. The temperature data of three positions from 13:16 to 25:25 on a certain day are selected for trend analysis. One measuring point every 5 minutes, a total of 41 measuring points, the regional temperature distribution trend chart is shown in Fig. 7.

The temperature distribution trend analysis of the secondary control cabinet area shows that the temperature above the secondary control cabinet is higher than the middle and lower parts. During the

inspection process, the operation and maintenance personnel focus on the equipment and wiring in the area above the secondary control cabinet, which can be taken at the upper part. Heat dissipation measures.

4.3. Regional temperature data analysis

When the DC system is overloaded, the ambient temperature determines the maximum current of the overload. However, due to the installation of a noise barrier around the commutation, the ambient temperature inside the barrier is much higher than the ambient temperature taken in the overload logic, which affects the temperature threshold calculated by the overload logic. For example, in summer, the temperature inside the barrier is much higher than 40 degrees, which is higher than the current design temperature of 40 ° C, and the oil temperature will be higher.

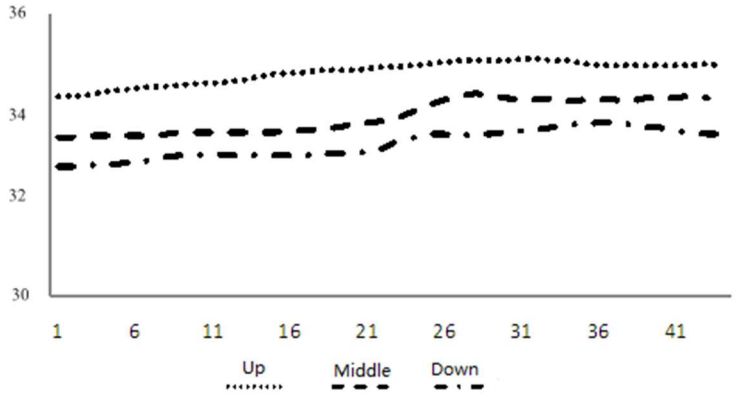

Figure 7. Trend of temperature distribution in control cabinet area

Based on the monitoring data of the Suidong Station, the correlation between load and temperature is analyzed. As shown in Figure 8, the load is strongly correlated with oil temperature and ambient temperature. Figure 9 shows the sample data distribution for oil temperature and ambient temperature, oil temperature and load. The increase of the ambient temperature affects the oil temperature and the line temperature. If the load is overloaded at this time, the high current and the higher oil temperature and line temperature will reduce the converter insulation strength, which is not conducive to the safe operation of the DC system.

In view of the above problems, using the monitoring data of the peak of the Suidong station during the summer, the temperature difference between the inside and outside of the barrier is analyzed, and a new ambient temperature threshold is proposed under the current conditions. When the temperature threshold is exceeded, the DC system is not allowed to operate under overload.

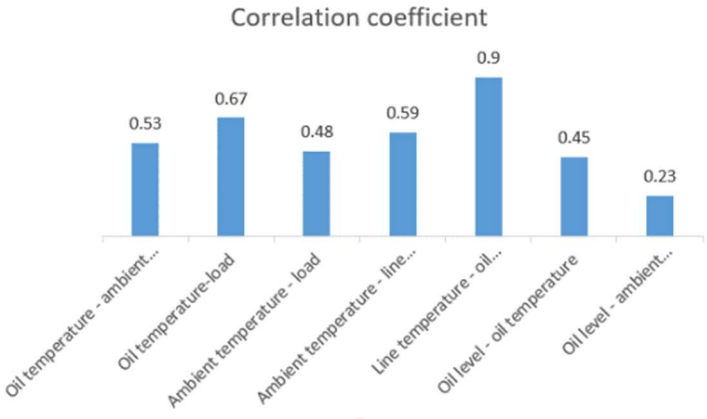

Figure 8. Correlation coefficient

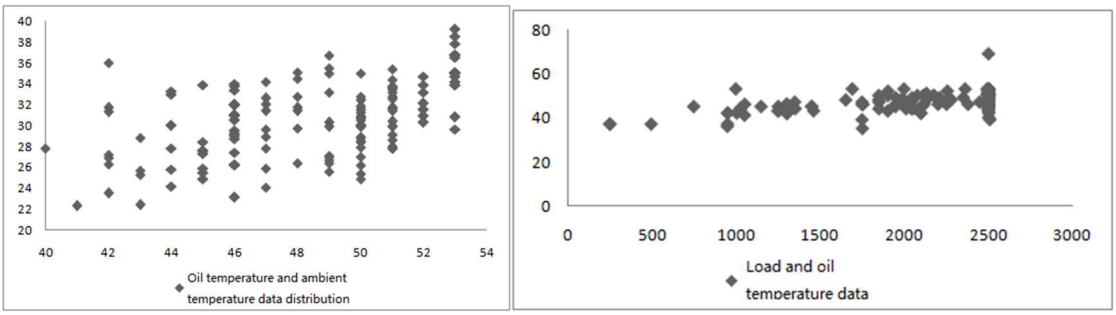

Figure 9. Data distribution

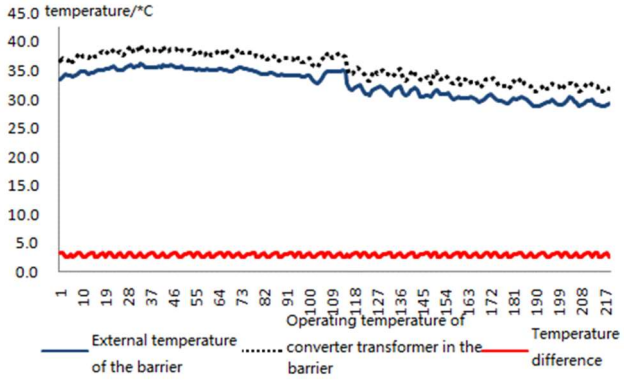

Figure 10. Data monitoring for internal and external environment of rheological barrier

By analyzing the temperature data monitored inside and outside the barrier in August and September, it can be seen that the internal temperature is higher than the external average by 3 °C. On the basis of the existing overload limit of 40 ° C, the correction threshold is 37 ° C, when the internal temperature is higher than 37 ° C alarm, to avoid overload operation.

5. Conclusion

Through the research and installation test of the offline acquisition system of the converter station area based on Bluetooth transmission, the system is easy to install and easy to read historical data, so that the operation and maintenance personnel can better grasp the temperature distribution of the secondary control cabinet. The environmental management of the secondary control cabinet accumulates effective basic data, and at the same time corrects the temperature threshold of the overload operation, promptly alarms, and avoids overload operation.

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