

Development of the Intelligent Voltage Monitor System for the 220KV Transformer Station

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Abstract: The hardware and software design for the monitor of multiple-channel voltages in electric power station.

Keyword: I-7000 modules, data acquisition, program design

The voltage monitor in electric power station is essential to the evaluation of the quality in different levels of electric network. It is the important foundation based on which the related authorities create the voltage chart, plan the electric network layout and arrange the proper operation manner. Currently the voltage monitor produced by domestic manufactures can monitor only one spot. The data acquired in real-time is stored in the EPROM. Because of its small capacity, the information used for analysis is very limited. The intelligent voltage monitor instrument development by the author of this paper is specifically designed for the Shumuling Transformer Station of Hunan Changsha Electric Power Bureau. It can monitor multiple loop circuits simultaneously and make statistic on the maximum and minimum value of voltage and the rate of qualified voltage. It can also have the capability to query and monitor the daily voltage curves and print the daily report and monthly report.

I. The basic features of the intelligent voltage monitor

- (1) This intelligent voltage monitor was installed in the Shumuling Transformer Station of Hunan Changsha Electric Power Bureau. It can monitor the two channels of 200KV PT voltage, two channels of 110KV PT voltage, four channels of 10KV PT voltage, two channels of 220V DC voltage and two channels of 380V DC voltage in real time. The monitor acquires the voltage sample by effective values. The sampling rate is one sample per second, with pre-processing storage. Take one minute as a statistical unit, and take the average pre-processed voltage value within one minute as the actual operational voltage of the system being monitored.
- (2) The ability to query by time
- (3) The ability to display in graphics mode
- (4) The ability to make statistic daily and monthly. And can display or print the voltage evaluation time, the rate of qualified voltage and the accumulated time, the rate of the voltage exceeding

the upper limit and corresponding accumulated time, the rate of the voltage exceeding the lower limit and the corresponding accumulated time. It can also save data up to 3 months.

- (5) The ability to printing in whole hour and the ability of maximum/minimum value and corresponding time print.
- (6) The ability to make data backup, data read and data delete etc.

Within the range of $\pm 20\%$ of rated voltage U_n , the composite measurement error of the monitor $r \leq \pm 0.5\%$

II. The hardware architecture of the system

The system architecture is show in Figure 1. The system consists of two I-7017 data acquisition modules, 1 RS232/485 conversion module ISA-7520 and 12 voltage transmitters.

I-7017 data acquisition module is an 8-channel analog input module manufactured by ICPDAS. It has 8 differential input channels, 16-bit resolution and up to 115.2K bps of communication speed. It's mainly used in industrial fields or other distributed data acquisition systems. It uses RS232/485/422 communications network and transfer the distributed signals to the master PC or control remote sites from via PC. It has a unique feature of dual watchdog design, i.e., the software watchdog and hardware watchdog. Each I-7017 module has an internal hardware watch dog. If the module is down, it can reboot in nearly no time. The master PC and each I-7017 module have a software watchdog interlock. In case the master PC is down, all the output modules will enter the pre-set safe mode, which is in compliance of the industrial safety requirement. If the RS-485 communication network is disconnected or under some other mal-functions, the host PC and the individual modules can not interlock or communicate with each other, which can also activate the software watchdog. The design of software watchdog is very clever and easy to use, and significantly improves the system reliability and safety.

ISA-7520 is an RS-232 /RS485 conversion module, which can be directly plugged into the extension slot of the PC without any working power supply. ISA-7520 has internal self-adapting functionality. It can check the data communication baud rate and data format automatically and thus accurately control the RS-485 network, decrease the system cost and increase the system reliability.

We use the WB400 series electric signal isolated sensor manufactured by Southwest Automation Institute as the voltage transmitter. This type of sensor adopts specifically designed isolating modules, when applied the in real time measurement of AC voltage in power network and circuit, it has the advantage of high precision, high isolation, wide frequency response, low drift, proof of impact, and high performance/cost ratio. The V411D1 module can convert the secondary 100V voltage of the PT to 5V DC voltage; the

V332A module can convert the 220V or 380v DC voltage to 5V DC voltage. Its level precision is 0.2, linear range is 0~120% of the rated input.

The I-7017 data acquisition module is installed in the field and acquires the output voltage signal of the transmitter in real time. It then converts the sample into RS-485 standard signal and transfer to RS-485 network. The I-7000 series products implement the voltage isolation of the field signals, and EIA RS-485 is a dual-direction compensating communication protocol that is widely used in the industrial fields, Only one pair of twisted wire is needed to send and receive data at long distance in a high speed. The individual nodes are connected in parallel. The module and module, module and network is independent of each other, thus improves the system reliability significantly.

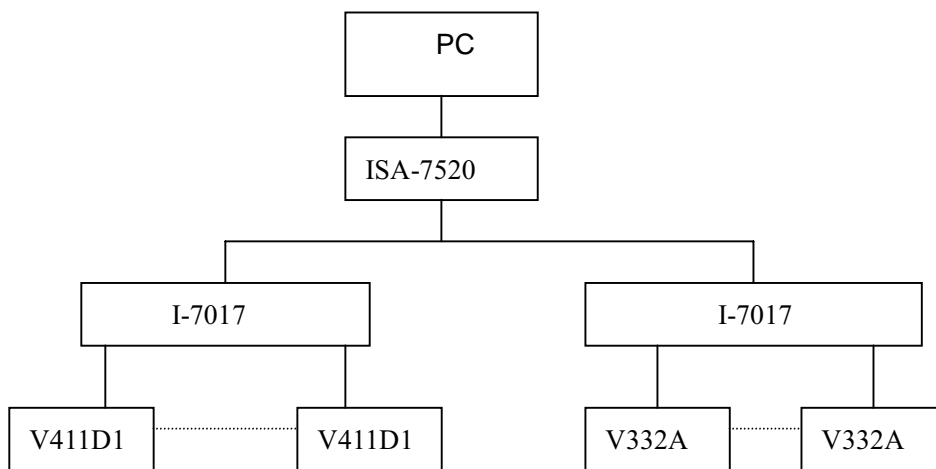


Fig. 1 System Hardware Diagram

III. The Software Architecture of the System

The system is developed using Powerbuilder 6.5. The system software is shown as following:

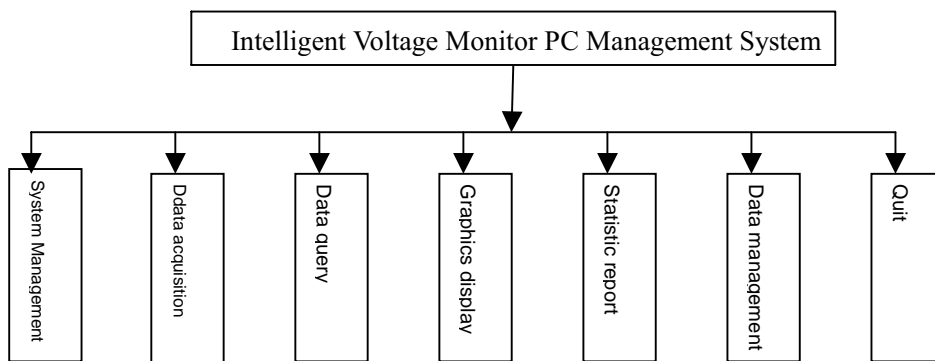


Fig. 2 System software diagram

1. System management

The system management module consists of user entry and print setting modules. This system software is used based on the different permissions.

In the system user entry module, you can enter the system user's name, password and permissions.

The system usage permissions can be divided into two categories: general operator and system administrator. As general system operator, you can only use data acquisition module, data query module and graphics display module etc. As system administrator, you can use all modules available.

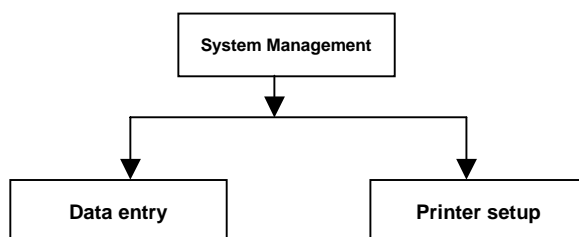


Fig. 3 System Management Module Diagram

2. Data acquisition

In the data acquisition module, you can get the real time data for the 12 different channels at one time per second. The average of 60 samples is stored as the value of one minute. In the data acquisition module, you can also use the automatic daily statistic report, i.e., every day at the time of 23:59:59, the system will automatically make a statistic on the maximum voltage value, minimum voltage value, evaluation time, and the time when the maximum/minimum voltage values appear.

Because PowerBuilder supports MS OCX, I use the MSCOMM32.OCX of VB4 to implement the communication with COM port. The implementation is as follows. First, add an OLE control in the window and choose MSCOMM32. The program for the comm port is as follows:

```
ole_comm1.Object.CommPort = 1 // ole_comm1 is the name for the OLE control. CommPort is the port.
ole_comm1.Object.Settings = "9600,N,8,1" //set communication protocol
ole_comm1.Object.InputLen = 0 //Initialize Input
ole_comm1.Object.PortOpen = True //Open COM port
ole_comm1.Object.Output = "#"+ "010"+ CHAR (13) //Send character to COM port
Do
    Yield() //wait until there is data in InBuffer
```

LOOP Until ole_comm1.Object.InBufferCount >= 1

ls_Output = ole_comm1.Object.Input //Get data

where, ole_comm1.Object.Output = "#"+ "010"+ CHAR(13) In order to send a command to the port, need to read the analog data from channel 0 of the I-7017 data acquisition module.

The interface for data acquisition is shown below:



Fig. 4 Interface for data acquisition

3. Data query

In the data acquisition module, according to the query time entered, the related records will be listed and can also be printed out. Data

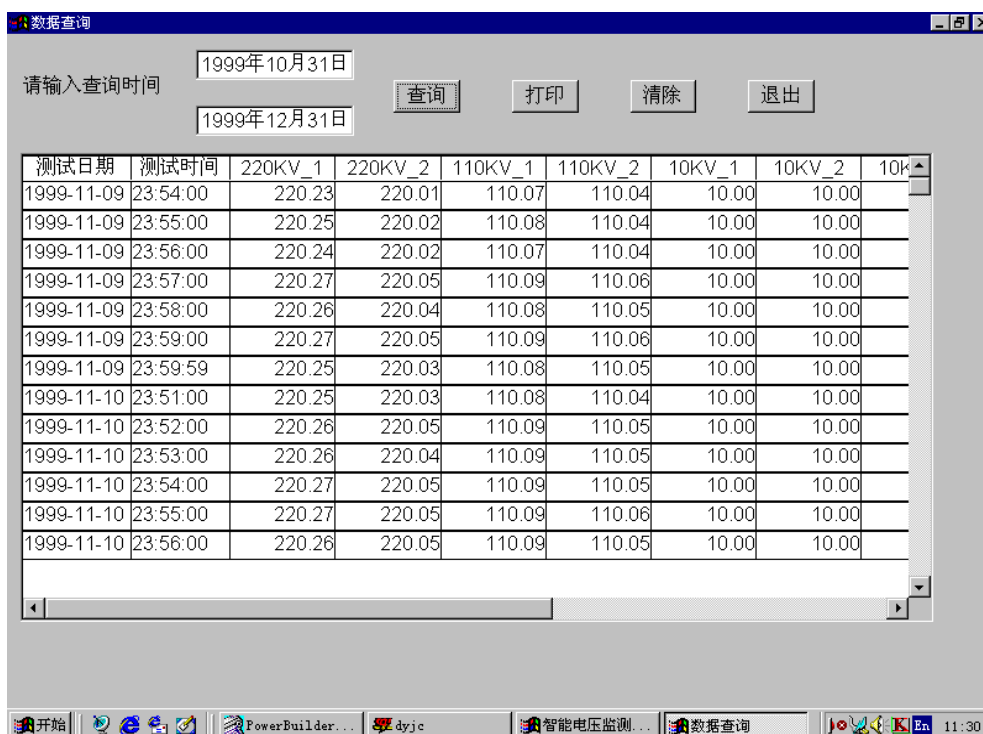


Fig. 5 Interface for Data Query

The interface for query is show in Fig. 5.

4. Graphics display

Click the graphics module, enter the time to query for, and choose the name of the line, you can retrieve the voltage sample value of this line on the entered date, and a curve of the change will also be displayed. Choose the print function, it can print out the voltage curve.

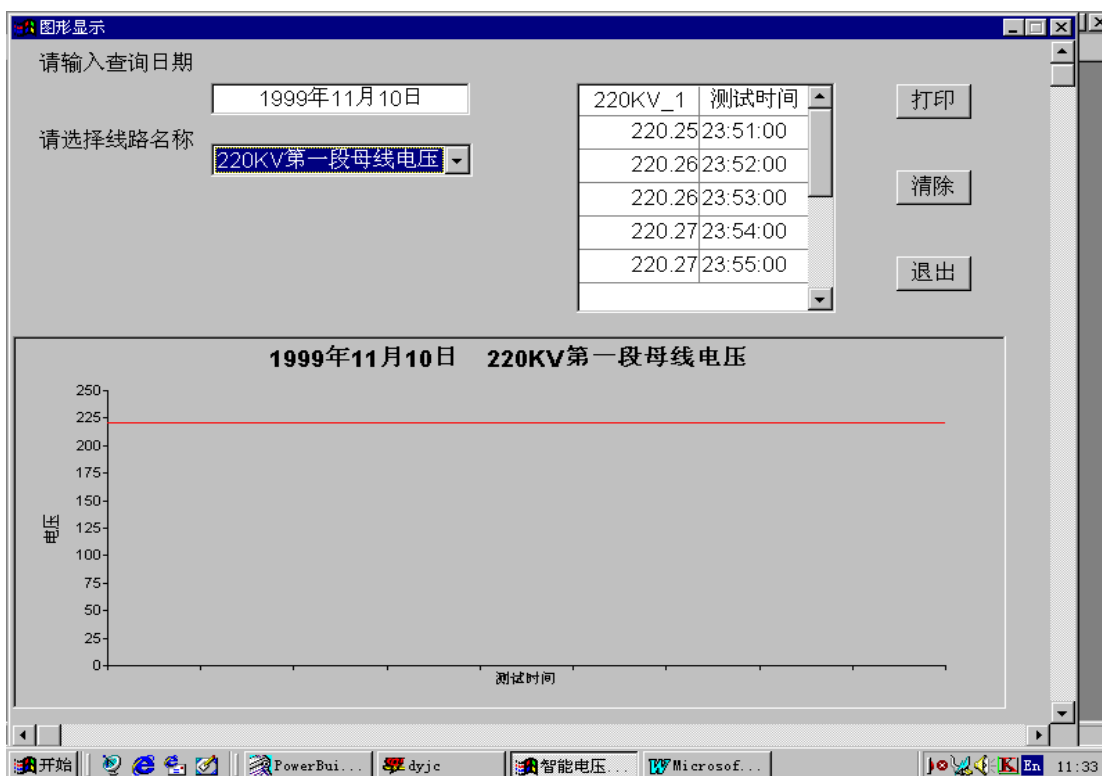


Fig. 6 Graphics interface

5. Statistic report

The statistic module consists of daily report and monthly report modules.

In the daily statistic window, enter the time to query for. The statistical information for the 8 lines on the given date about the total evaluation time, out-of-upper-limit time, out-of-lower-limit time, qualifying ratio, maximum value, minimum value, time for max. value and time for min. value and the average value of the day will be made. Press Print, it will print out the daily report. In the monthly report, you can get the statistic of the month and the statistic for the year. This means after you enter the query month, it will make a summary on the total evaluation time, out-of-upper-limit time, out-of-lower-limit time, qualifying ratio and annual accumulated out-of-upper-limit time, accumulated out-of-lower-limit time, accumulated power supply time and accumulated qualification rate. Press Print, it will print out the monthly report.

The interface for the daily statistic report window is shown in Fig. 7.



Fig. 7 Daily Report

7. Data management

Data management module includes data backup, data removal, data entry and monthly statistic functionality.

Enter the time period for which you would like to back up the data in the data backup window, it will retrieve the corresponding data and stores onto hard disk.

If the stored data is too old, you can remove the data after you have retrieved them from the data removal window.

Data entry interface can restore the backup data into the database.

IV. Conclusion

This intelligent voltage monitor has passed electromagnetic compliance experiment and precision evaluation by Hunan Electric Power Experimental Research Institute. All the data fit the design specifications. The user-friendly interface and easiness to use of the software has earned wide welcome.