Design of SCADA power Distribution Monitoring System based on PLC and Configuration Software

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***Abstract*—The system is based on PLC and configuration software, and the SCADA power distribution monitoring system is designed. The system uses PLC to collect various intelligent instruments on site and electrical parameters of devices. they will be uploaded to the monitoring system by the switch through the serial server. The configuration design uses FameView monitoring configuration software to achieve data real-time display and status display for field equipment through configuration images. The reports, database, curves, and other systems can also be integrated so as to help query historical data. The debugging and running experiments show that the system is characterized by easy operation, stability and safety. It achieves the design objectives.**

Keywords-configuration, data acquisition and supervisory control, distribution system, FameView

I. INTRODUCTION

Power distribution SCADA system is a computer-based production process control and scheduling automation system. It uses the data acquisition module to monitor and control the operation of field devices so as to achieve data acquisition, device control, measurement, parameter adjustment, and various signal alarms. The power distribution SCADA system has many advantages, such as information integrity, efficiency, correct grasp of system running status, speeding up decision-making, and can help quickly diagnose the failure state of the system. It has become an indispensable tool for power dispatching.

This design mainly uses configuration software to conduct configuration design for the power distribution monitoring system. It can achieve data real-time display and status display for field equipment and integrate with reports, database, curves, and other functions so as to help query historical data.

II. SYSTEM DESIGN

A. System Architecture

The system architecture of the power distribution monitoring system can be divided into three layers, namely system monitoring layer, communication management layer, and field device layer.

Field device layer: includes low-voltage & medium-voltage switchgears, various intelligent instruments, computer protection, etc.Communication management layer: includes switch, serial server, PLC;System monitoring layer: includes background monitoring system and management, acousto-optic alarm, printing system.

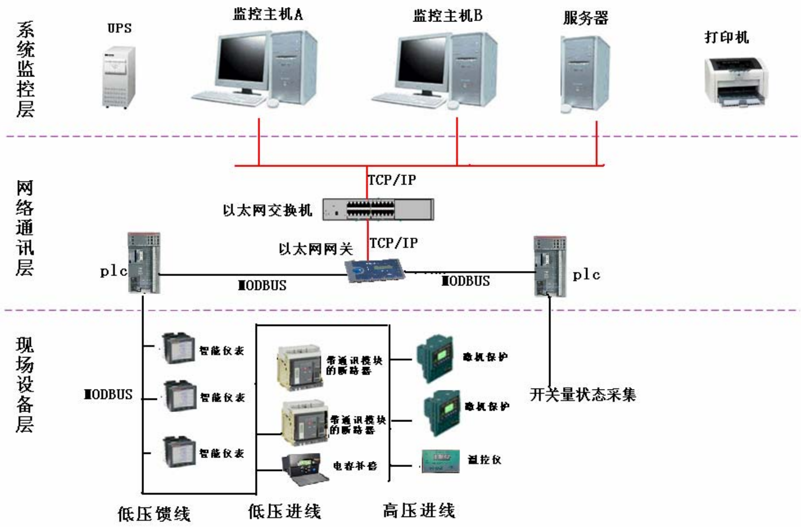

Figure 2-1 Topology of the system

Topology of the system is shown in Figure 2-1. The monitoring layer of the system includes two sets of monitoring host (redundant system), one set of database server, and one set of field acquisition device. MODBUSRTU communication protocol is adopted, and the serial server is used to transform it into Ethernet signal in order to upload it to the background monitoring center.

B. Design program for the monitoring system

1) Overall program

By using computer technology and taking computer protection device, network instrument, and breaker as the core, the control, signal, measurement, billing and other circuits can be included in the computer system so as to replace the traditional control protection screen and improve the reliability of system. The SCADA system can monitor and control equipments operated on the site so as to achieve functions, such as data acquisition, measurement, parameter adjustment, and various signal alarms.

The power distribution monitoring system uses two monitoring hosts (one main host, and one standby host) to call and monitor the load status, load distribution curve, important alarm, accident statistics, working status, and other electricity monitoring data of various substations. The monitoring system also uses one database server to store historical data and provide other devices with database access service. The server can exchange data with the monitoring system through the switch. The monitoring system uses PLC to collect field data and analyze & process data information. On this basis, it makes various electricity utilization programs for the college.

2) Operating principles of the system

- Real-time data of field device can be collected by PLC. Then, it can be connected to the switch through the serial server and uploaded to the monitoring system.
- Monitoring host A and monitoring host B make up the redundant system. Host A is the commonly used machine, and host B is the spare machine. If host A is under normal operation, host B is in the hot standby status; if host A has a failure, it will immediately switch to host B and start the hot standby monitoring system; if host A recovers from the failure, it will immediately switch to host A, and host B enters the hot standby status.
- The database provides data storage and call services, and other machines and WEB clients can access the database through the switch.
- WEB publishing system can publish web pages. After passing the client authentication, any computer in the school which is connected to the Ethernet can visit the monitoring system so as to query electricity consumption history of the department.

3) Implementation functions of the system

a) Data acquisition and processing

The system integrates with data acquisition and processing function, which can achieve real-time acquisition of data of various circuits in substation of the college, and send the data to the monitoring system. The data can be real-time updated and displayed in the monitoring system. The monitoring system uses the data collected to simulate real-time operation of substations. Once there is an abnormality, it can be timely treated. The quality of power supply is improved.

b) Reporting system

Historical reports. The system has a powerful reporting function. It can print or preview variable data which defines inventory in the database, and automatically generate shift reports (8 hours per shift), daily reports, weekly reports, monthly reports, quarterly reports, and annual reports.

Real-time reports. The system can automatically print through alarms. The monitoring system triggers alarm printing through alarm variable. When there is a variable alarm, the printer will automatically print alarm type data value and alarm time of the alarm variable.

c) Monitoring alarm function

State changes of various switching values and circuits can be real-time monitored through data collected, and switching values of various circuits can be reflected in the system diagram. If there is a change in switching value, the monitoring system will issue the alarm panel which specifically shows the reason of the alarm. It will flash and change color, coupled with voice alarm. It will also wait for the confirmation by the staff on duty.

Variable data can be monitored. The comparison between defined alarm value and actual value of data collected will be conducted. If the actual value is higher or lower than the alarm value, the monitoring system will issue the alarm and wait for the confirmation by the staff on duty.

d) Curve query

It can be divided into two query solutions, namely historical curve query and real-time curve query. The historical curve query offers curve query and historical value query for archived data. Data and curves at any time can be found to directly reflect the operating conditions at that time, greatly helping technicians analyze data and formulate reasonable management programs. It also provides parameter query, such as power, voltage, and current.

e) Historical data archiving

The system provides historical data archiving. Historical data can be easily called and queried, which can clearly reflect various kinds of data when a fault occurs.

f) Web publishing system

The system integrates with Web publishing system. Departments of the college can browse their electricity consumption records on webpage in order to understand their electricity consumption. If departments can understand their electricity consumption records (lighting, air conditioning, etc.) of any time, they can adjust electricity consumption strategies in accordance with electricity consumption data. In this way, they can understand whether there is waste of resources, such as even-burning lamps in non-working time, and computers and air-conditioners are not switched off in non-working time.

g) Remote meter reading function

The remote meter reading function of monitoring system can trigger one database connection per hour and conduct data archiving. Meanwhile, it can trigger data of any time by pressing the button and store data. In this way, the system can finish the meter reading task of any or all substations. It improves the quality of meter reading and overcome many shortcomings of manual meter reading, such as time-consuming, more errors, out-of-sync and so on.

III. CONFIGURATION INTERFACE DEVELOPMENT

The configuration software of this design uses FameView monitoring configuration software. Development interface uses a tree structure menu, which is divided into 7 drop-down menus, namely my system, basic applications, extension applications, database, data services, and enhancement applications. Each menu has subclass application items. Development steps are as follows:

A. Definition system

Newly constructed projects first need a definition system. The system has many functions, but only some of them are used for specific users. Through the system customization, it can make the project simplified and specialized. After the definition of system functions, the task should be enabled. Settings of the system should be conducted based on customer's operational requirements. The system customization and definition start task option window is shown in Figure 3-1.

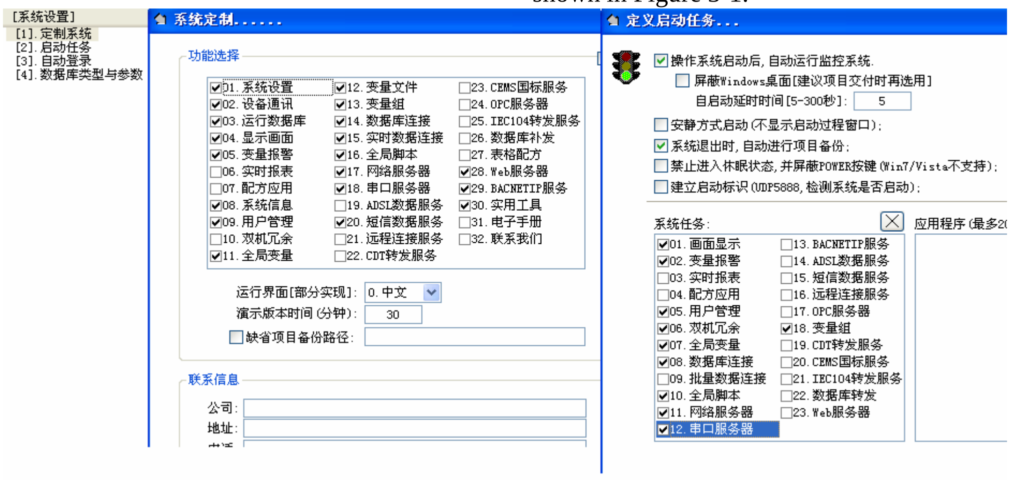

Figure 3-1 System customization and definition start task option window

B. Device communication

The system provides a variety of device drivers. The driver needs to be installed if device communication is used. Similarly, 7188E3 serial server also needs to install the driver.

After the installation of driver, the driver needs to be booted. Then, the device data sheet can be created. When creating the device data sheet, remote parameters (such as, the station number, TCP port number, conversion device IP address) and communications data (such as, data type, access method, cell format, starting address, length) should be added. The window to create device data sheet is shown in Figure 3-2.

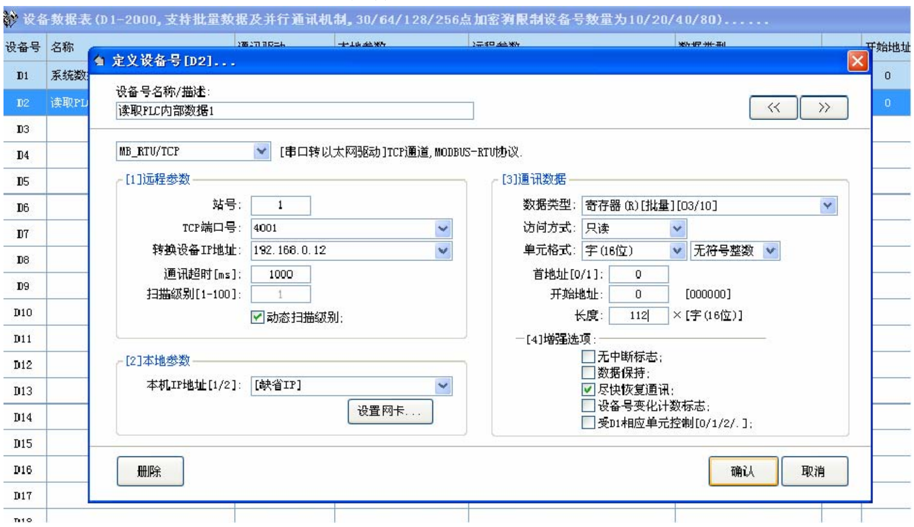

Figure 3-2 Window to create device data sheet

C. Variable creation

After the device communication configuration, variables can be created. Variables include analog quantity, switching value, internal switching value, internal analog variable, etc.. Window to create variables is shown in Figure 3-3.

Figure 3-3 Window to create variables

D. Image configuration

Image configuration includes various field devices, including transformers, switches, etc.. The # 1 transformer low-voltage switch configuration interface of this design is shown in Figure 3-4, including real-time display of various phase currents, line voltages, phase voltages, active power of triphase, reactive power, apparent power, active electric energy, reactive electric energy, power factor, frequency, etc.; setting of ranges and variables, query of history curves, image printing, and other functions.

Figure 3-4 Interface of 1# transformer low-voltage switch configuration

E. Reporting system

Through the SQL database connection, process variables and database field correspondence can be edited in database connection, archived data can be established, and historical data can be offered for history reports. The reporting system interface of this design is shown in Figure 3-5. The system provides various phase voltage & current values and electricity consumption data.

Figure 3-5 Reporting system interface

IV. CONCLUSIONS

Power distribution SCADA system installed for the substation of Library and Information Building of the college is currently under stable operation. Its data acquisition is fast, and the data refresh time is less than 2S. The data acquisition is accurate, and the data storage, measurement, parameter adjustment, and various signal alarms of substation can be realized. It reduces the pressure of electricians on duty, ensuring the safe and reliable power supply. Power distribution SCADA system greatly improves the degree of automation in terms of remote meter reading, data archiving and analysis, curve analysis, etc.. It can achieve the digitalized and intelligent substation and scientific management, which has broad application prospects.

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