The Applied Research for Industrial Ethernet in Reactive Power Compensation Control System

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Abstract: With the rapid development of computer, control and communications technology, Smart Grid has got a rapid development and preliminary application. Reactive power compensation system plays an important role in power supply system all the time. Therefore, reactive power compensation system is into Smart Grid, and realizes the remote monitoring, which has very important significance. The industrial EtherNet for industrial control area bad become an inevitable trend. First of all, this paper analyses the advantage of the industrial EtherNet, then, this paper briefly discusses feasibility and necessity of the Industrial Ethernet applications in reactive power compensation system, and proposes the hardware and software design of network interface of reactive power compensation system. In the system software design, using Linux and QT improves stability and scalability of system. The practical test shows that the system can be into Smart Grid, and realize the remote monitoring of system, believe that it will have broad application prospects.

Keywords: : Smart Grid; Industrial Ethernet; Reactive power compensation system; Linux; QT

I INTRODUCTION

With the rapid development of computer, control, communications technology, Smart Grid has got a rapid development and preliminary application. Reactive power compensation system plays an important role in power supply system all the time. Therefore, reactive power compensation system is into the smart grid and realizes remote monitoring, which has very important significance. Currently, Reactive power compensation system generally communicates with PC through the RS-232, RS-485 . With the continuous development of Industrial Ethernet, Industrial Ethernet combines advanced Ethernet technology and distributed real-time control technology, its real-time is well resolved, and it is gradually recognized by the market in the industrial control area. Therefore, the Industrial Ethernet application in reactive power compensation system has become a necessity. This paper analyzes the advantages of industrial Ethernet, and raises application of industrial Ethernet in Reactive power compensation system, including the hardware design and the software design [1].

II THE ADVANTAGES OF INDUSTRIAL ETHERNET

Industrial Ethernet is essentially a field of Ethernet in industrial control applications. Ethernet is the most widely used computer network technology and has extensive technical support. Therefore, if Ethernet is used in industrial control area as the fieldbus, it can ensure the choice of the multiple development tool and development environment [2]. In fact, Ethernet has become the control network management and monitoring agencies in the unanimous choice of the network layer. And the cost of Ethernet is low, because Ethernet is most widely used, so it gets the close attention and wide support by the hardware development and the production company, and it has a variety of hardware products for users to choose. Ethernet communication rate is high, the current rate of Ethernet communication 10M, 100M Fast Ethernet is also widely used in the beginning, 1000M Ethernet technology is mature, 10G Ethernet is also under consideration [3]. The rate is much faster than the current fieldbus. Ethernet is easy to implement management and control integration, and easy to implement control of network and information network for seamless integration, to build a unified enterprise network. It enables embedded controllers, intelligent field instrumentation and sensors, measurement and control to easily access an Ethernet network, connecting up with the Internet[4].

III HARDWARE DESIGN

Figure 1 shows the overall hardware of Reactive power compensation system.

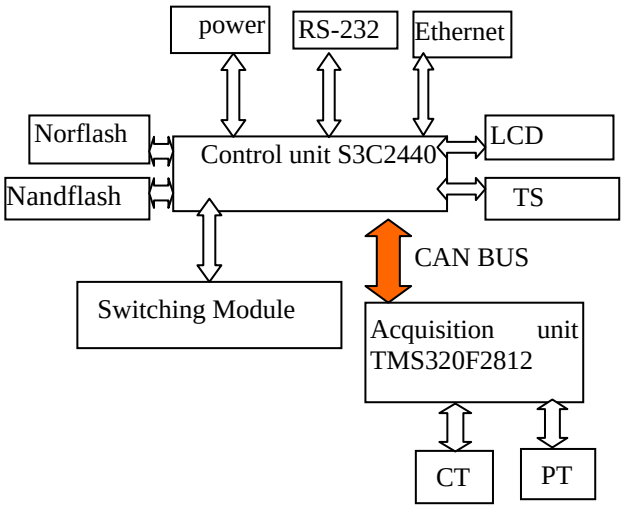

Figure 1. The hardware structure of reactive power compensation system

To improve the stability, scalability and real–time of system, and better performance of industrial Ethernet, the system uses a dual-CPU structure, the control unit and the acquisition unit [5]. The main processor of the control unit uses high-performance ARM9-based 32-bit RISC architecture microprocessor S3C2440, S3C2440A microprocessor is a semiconductor company Samsung introduced by the high-performance, low power, highly integrated and have the industrial temperature range and performance of the microprocessor. Acquisition unit uses the digital signal processor TMS320F2812 as the core. TMS320F2812 digital signal processor is the TI company's latest 32-bit fixed-point DSP controller and one of the most advanced processors of the control. The control unit and the acquisition unit exchange data through the CAN bus, in order to improving the stability and real-time of system.

Select the Ethernet controller chip, DM9000, as Ethernet interface (Figure 2). It is fully integrated, low cost, single speed, and with general processor interface, 10/100M adaptive, and 4K-byte static access memory. It is designed for low power consumption, high processing performance, supports 3.3V to 5V tolerance. DM9000 provides an MII interface to connect HPNA device or other support MII interface transceiver, and supports 8-bit, 16-bit, 32-bit interface to adapt to different processors access to internal memory. It supports the IEEE802.3u standard, and also supports IEEE 802.3x full duplex flow control. Select RJ-45 connectors HR911105A, which built-in network transformer, Isolation transformer plays the role of the network signal transmission, impedance matching, wave repair, clutter suppression and high-voltage isolation, to protect the security of the system.

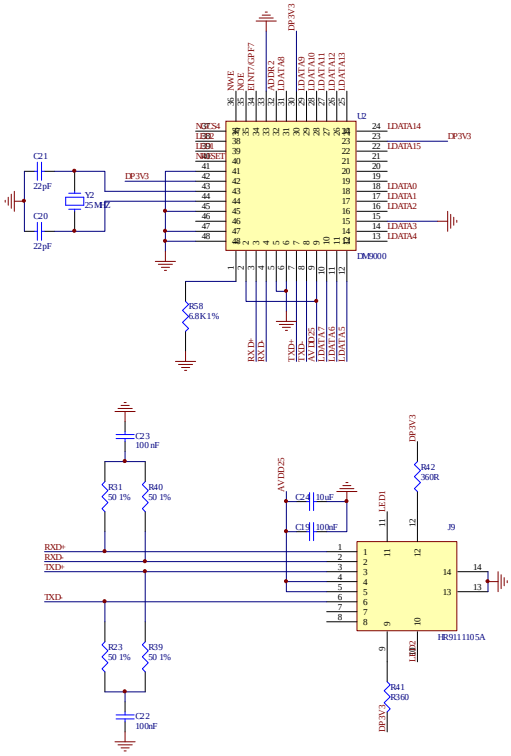

Figure 2. Industrial Ethernet interface hardware circuit

IV SOFTWARE PLATFORM

To achieve industrial Ethernet in the application of reactive power compensation system, NIC driver and TCP / IP protocol implementation is key, therefore, select to transplant embedded Linux, which has embedded the TCP / IP protocol stack, so that TCP / IP protocol to achieve. Embedded Linux system has supported multiple types of cards such as various 10M/100M, 1000M of Ethemet LAN, etc. For DM9000E Ethernet controller, embedded Linux has provided good support, in the transplanting process, to need only modify the source code, and configure the appropriate modules to support the network. In network programming under LINUX, we can use the unified sockets interface that LINUX provides. However, this approach involves too much structure, such as IP address, Ports transition, unskilled people are likely to make such mistakes as. Therefore, to transplant the QTE, QT SOCKET provides full use of the class encapsulation mechanism, so users do not need access to the underlying operations of various structures. And using QT's own signal-slot mechanism to write the program is easier to understand[6].

V PROTOCOL DESIGN

The system integrates the MODBUS protocol and Ethernet TCP / IP into the industrial Ethernet MODBUS TCP protocol to design, the protocol uses the communication module of client/server. Embed Modbus in TCP frames in a simple way, and use it as the

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application layer protocol of industrial Ethernet. Modbus TCP protocol structure is shown in Figure 3.

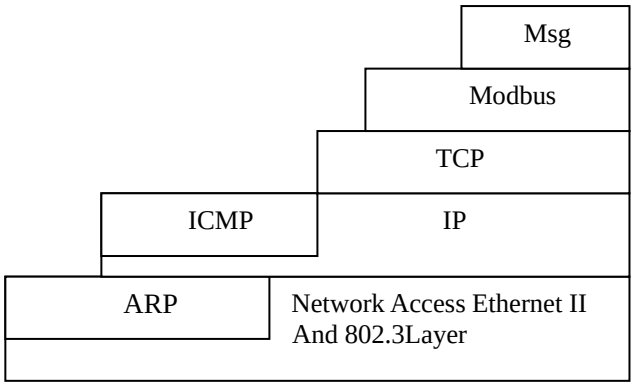

Figure 3. MODBUS TCP protocol structure

In order to maintain a thinking of protocol hierarchical, commonly use methods of connection-oriented in design work, namely, networking connection needs to pass three steps of "connection, communication and release of connections"[7]. In a simple variable, it can obtain by only "registered" tokens, In Modbus variables, it can obtain by a clear "programming path" performance, This performance suggests that both sides communicate in accordance with the agreement until the connection is terminated.

VI SOFTWARE DESIGN

In the control system of reactive power compensation，Industrial Ethernet interface realizes PC communication and remote control. The software is completed by QT. To improve the system's real-time, use Qthread of QT to open a thread to process data. The operation process of software system based on Industrial Ethernet communication is as follows (Figure 4),

After the system powers, system first completes the system initialization and then repeat the test execution, when reactive power compensation system and PC Establish connection, system can carry out normal communication. When the network host computer generates a request packet, communication module will detect the request packet identifier. If the destination of the packet is the control system, then completes the unpacking of MODBUS TCP protocol, and stores the data in different buffer, and then sets message reception mark, and finally back to the main loop of the thread. If the main loop finds that the receiving mark of the message is set; it will call the corresponding subroutine packet processing on the packet. If the main loop finds that the sending mark of the message is set, will call the Ethernet send subroutine of the message to complete the conversion of Modbus TCP protocol and send the message. After the response message is sent, it will generate the sending interrupt, the sending interrupt

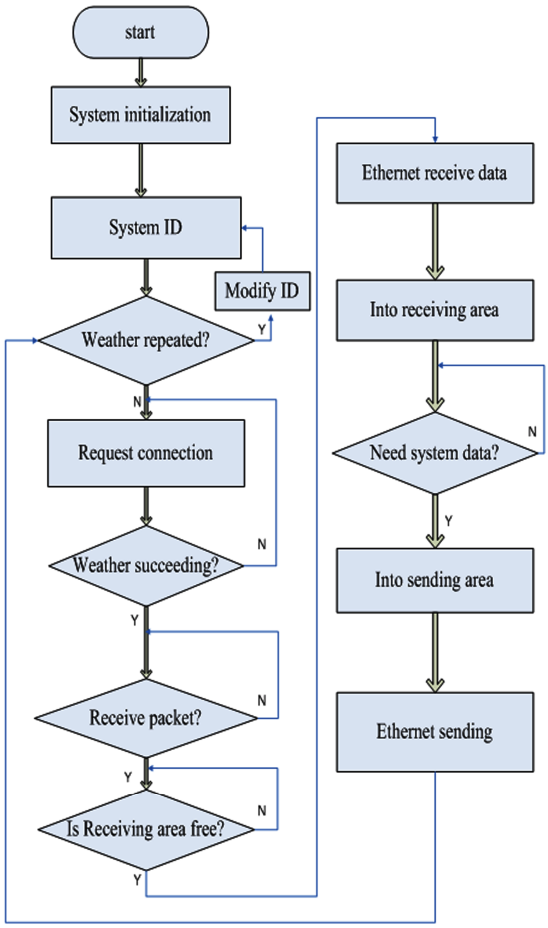

Figure 4. Flow chart of Industrial Ethernet Software

handling routine clears the corresponding latch flag. At this point, complete the data transmission process.

VII CONCLUSION

Smart Grid is the development trend of Power Grid, the development and application of the Industrial Ethernet technology are becoming more mature to make it possible for field application. Based on the MODBUS TCP Ethernet protocol analysis，this paper discusses the application of industrial Ethernet in reactive power compensation control system, and gives a detailed software and hardware design. Through testing, the remote monitoring computer realizes real-time monitoring to the reactive power compensation system by Ethernet. Realizing various Ethernet protocol conversions is the later work of the system, and has been the actual test. Reactive power compensation system is only one of power systems, I believe that this system design method for the other similar power system provides a reference for the application.

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