Development for Protocol Conversion Gateway of Profibus and Modbus

Hao Zhang\(^a\), Yanan Li\(^a\), Huiling Zhu\(^b\)*

\(^a\)Qinggong College, Hebei United University Tangshan,063000, Hebei, China
\(^b\)CHINA 22MCC GROUP CORPORATION LTD., Tangshan,063000, Hebei, China

Abstract

Profibus and Modbus are two more common industrial field bus, they were widely used in industrial control field. Because the two buses can’t interconnect with each other, we design a gateway for Profibus and Modbus to achieve Profibus and Modbus protocol conversion. When designing the gateway, the MCU is AT89C52, protocol chips were selected Siemens SPC3, and describes the process of protocol conversion. Gateway is used in industrial field, enabling Profibus and Modbus protocol conversion. The cost of gateway development is low, it can adapt to the complex environment of industrial field, which brings certain benefits to manufacturers.

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1. Introduction

Profibus and Modbus are two completely different bus, bus protocols (link layer and application layer) is entirely different. Two bus devices to achieve the data exchange, data link layer to application layer protocol were converted, the gateway is to complete this function. A gateway will send the unpacked data to link layer and application layer respectively, and get the ultimate user packet data; and then gateway will get the user data bus device B, in accordance with model layer by layer protocol package, converted

* Corresponding author. Tel.: +86-15032439180.
E-mail address: mox012@163.com.
to bus device can identify the data type B, at last send data to the bus to device B. Like a protocol converter gateway, the bus protocol data link layer and application layer protocol conversion repeat the above work again and again. Therefore, the gateway does not require bus protocol data link layer and application layer is exactly the same, it converts protocols, and also increases the flexibility of the system.

2. Profibus and Modbus protocol analysis

OSI reference model is a seven-layer’s structure, which can support a strong network communication. OSI is a general reference model, it is rich in functions to solve various problems that may arise. When achieving communication between the workshop level in the industrial field, the designer should consider the following factors: First, to constitute a real open interconnection system, how to create and choose the proper network Communications reference model, whether Open Systems Interconnection model meets the conditions of the special status of industry or not, and simplifying it still meets the control network or not.

The bottom of the field of industrial control equipment and instruments to the middle of the control unit are splitted up by Profibus protocol. According to different application areas, communication protocols were carried out to integrate and simplify, therefore, data can communicate only requires simple interface. Different from OSI communication model, Profibus network model only contains three layers, namely 1, 2, 7 layer. Physical layer (PHY), field bus data link layer (FDL), the user layer (divided into user interface and direct data link layer mapping layer)

According to the international OSI 7 layer network model, the standard Modbus protocol defines the communication physical layer, link layer and application layer..

Physical Layer: the asynchronous serial communication standard of RS232 and RS485;

Link Layer: provides the number identification based station, master / slave mode of medium access control;

Application Layer: provides the information specification (or message format) and communication services;

There are two communicate modes about ModBus protocol ASCII mode and RTU (Remote Terminal Unit) mode. ASCII mode is a byte into two ASCII characters to send, while RTU mode is in hexadecimal form to transmit data, a byte is one frame, so efficiency of data transmission is more than ASCII mode, the majority of industrial controllers are using RTU mode. In the same network, regardless of the master or slave, must use the same communication patterns and the same transmission rate. At present, commonly transmission rate of ModBus protocol is 1200 bit/s ~19200 bit/s. Figure 1 shows Modbus data frame format.

The four parts of Modbus data frame form are as follows:

![Fig 1 Modbus data frame format](image-url)
3. Gateway

3.1 Hardware Design

SPC3 is a station dedicated for intelligent communication protocol from the chip to support the Profibus-DP protocol. SPC3 can be completed independently all communications of Profibus-DP, it can speed up the communication rate, and reduce the workload of the microprocessor interface module. SPC3 is integrated in the OSI model several parts of functions, including analog physical layer transmission (RS485 driver), slave site of the bus data link layer protocol (2a layer), support on the upper interface (2b layer), some FMA layer 2 tools and complete DP slave protocol (user interface, allowing users to visit on layer 2). Other Layer 2 functionality (software tools and management) must use an external microprocessor software.

The main controller for the 89C52 and the connection diagram SPC3 is shown as Figure 2, SPC3 can be independent from a state machine transition, to communicate with the master. SPC3 master can read the data input buffer or output buffer is written to the output data. Only when the SPC3 into the data exchange state, its input and output buffer read and write makes sense.

![Fig.2 89C52 microprocessor and SPC3 connection diagram](image)

Modbus interface circuit is shown as figure 3. Here using RS485. The interface rate of the RS485 is slower than Profibus, so we can use MAX487 chip and a low rate of optical isolators H11L1. At 9600bps baud rate, the normal communication can be guaranteed. Interfaces used in the 485 regulator and transient suppression pipe to be protected on the MAX487 chip.

X25045 is selected as the watchdog circuit chip, due to protocol conversion interface needs to be installed in the industrial field, the surroundings of the scene must be considered, the main controller will often be disturbed from outside interference, such as electromagnetic signals and so on. This may allow programs to run some errors, this process tends to produce an infinite loop, therefore, the control system may be paralyzed, it will cause losses and serious consequences are incalculable. Applying watchdog...
chip, to avoid running when disturbed by external factors, allowing the main controller in a state of neglect by the chip under the real-time monitoring.

![Modbus interface circuit](image1)

### 3.2 Protocol Conversion in Gateway

Bus transport is in the type of the master-slave way, data issued from the main station, transfer to the slave station. It is a logical, virtual, or a field bus device can be either terminal, it can be sent to the station. When the fieldbus devices you want to send data, the data will be packed from top to bottom layer, then the format of the data transfer out. Receiving data from the station after the first layer unpack the data, analyze the data. When the data format is correct, it will accept the data. Profibus and Modbus is based on this transport way.

![SPC3 configuration test](image2)
When the heterogeneous data bus needs to exchange information, the gateway will play conversion role. Gateway hardware with PROFIBUS-DP and Modbus port, the software will be set up respectively with PROFIBUS-DP and Modbus interface program driver. Modbus interface for data and PROFIBUS-DP interface, the user data were unpacked layer by layer to protocol conversion, it is converted to desired bus protocol, and then send the data to complete data communication about PROFIBUS-DP and Modbus devices equipment.

If the data is sent, then the program reads DP master site’s from the SPC3, and data into buffer 1 (buffer1), set the two pointers 1 and 2 (p1 and p2) for writing and reading data. Until the buffer 1 is empty, indicating data transmission is completed. This is the beginning of transfer data in the buffer 2 (buffer2), change the DP form into Modbus format, which includes data validation, and then gateway distributed data to Modbus (slave site), receives data from the station, data back to the gateway, and decode packet data conversion into DP format, distributed to the master, so completed a data conversion. figure 4 is shown as SPC3 configuration test.

4 Conclusion

Development for Profibus-DP and Modbus protocol conversion gateway and use of the gateway can support all of these two protocols to the field device data into the main control room. Since our objective conditions, Modbus products will be in China for a long time and have a broad market in the future. Profibus-DP is the world's most widely used field bus technologies. Therefore developing a two-bus integrated gateway have a more important practical significance. This simple, reliable and practical means of communication can be extended to the industrial field. This paper discusses the conversion of the key problems and solutions ideas, the proposed protocol conversion principle can be extended to other bus protocol conversion applications. The gateway will further promote the development of both the application and development of the bus.

References


