2014

ISSN : 0974 - 7435 Volume 10 Issue 21

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(21), 2014 [12780-12785]

Research on communication techniques between PLC control system and fieldbus technology

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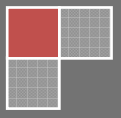
ABSTRACT

In industry, with the rapid development of automation technology, communication technology continues to change and develop under the impetus of the PROFIBUS. In factory automation workshop, the monitoring machine in field equipment layer can use PROFIBUS for data communication and control. Through PROFIBUS, it can not only realize the integrated automation requirement of the factory, also can realize the intelligent requirement of the field devices. All of these are based on the real time communication between PLC and field devices, servers and client to achieve. The combination of PROFIBUS and PLC control system can not only realize high speed and real-time of communication system, also can significantly improve the stability and security of the system. Therefore, in the field of industrial automation, the study and application PLC control technology and PROFIBUS is of great significance. Under the support of fieldbus technology to study and apply PLC control system can help achieve factory automation. The study begins with an overview of the PLC communication function, and describes the basic characteristics of the fieldbus, and based on the past application results PLC dedicated fieldbus are discussed in detail. Then the study discusses the PLC control system based on PROFIBUS and CAN bus. In summary, based on the above discussion, the study put forward the development direction of PLC control system in the informationize process of manufacturing industry.

KEYWORDS

PLC control system; PROFIBUS; CAN bus; Communication protocol.



INTRODUCTION

With the rapid development of computer network, communication and control technology, automation system also has carried on the profound changes in current equipment layer of the production site, information technology is rapidly penetrating from the production workshop to enterprise management. Information technology is gradually covering all aspects, and communicates each link from the production of raw materials to the market selling; on the basis of the network control gradually form a complete enterprise information system[1]. With this trend, the fieldbus technology develops rapidly.

In the original definition, fieldbus refers to public signal transmission line between field devices, but with the continuous development of technology, the current fieldbus technology has recognized description. Field bus is specified defined as data bus installed between the region of manufacturing or production process and various devices that control the region. The production process includes intermittent production process and continuous production process, and the devices mainly refer to a variety of equipments, instrumentation and automatic control system. The relationship between the instruments to achieve serial communications, digital and multi-node, the exchange of information between nodes is implemented by bus for final completion of automatic control of all network nodes[2]. With the continuous development of fieldbus technology, it exhibits a wide range of application prospect in automation systems of more and more industries.

PLC dedicated bus

Network nodes of fieldbus are usually measure control equipment, and transmission link are twisted pair medium. The measure control devices in production sites are connected through network nodes and transmission link to form a network system. The devices have the capability of digital computing and digital communication, so in the application an open specification of communication protocols should be followed to achieve data transmission and information exchange, the systems that use remote monitoring computer in field device for automatic control can meet the needs of the various applications[2]. Computer network connected scattered single computers to lead the human into an information age, in the field of automation, the fieldbus plays the role of computer network, it connects devices interaction to form a control network, and then connects the computer network to form information network. Since fieldbus has been produced, there are a wide variety of it, fieldbus involves in this paper includes PROFIBUS (Process Field Bus) and CAN (Controller Area Network), these two kinds of fieldbus control the running of the system, so the fieldbus system has openness and mutual maneuverability, at the same time, as the fieldbus is the hub of communications, so fieldbus must have the real-time performance of communication and the adaptability of the environment[3]. The advantages of both systems and communication features make fieldbus demonstrated outstanding advantages: users of the system with an integrated initiative, investment and installation costs can be saved, and also improve the accuracy and reliability.

In the computer integrated manufacturing and integrated operating system, field bus belongs to the bottom control network, its technology is based on open systems interconnection model, also known as the OSI model; its technical characteristics is to make the scene of the communication network and instrument even distribution throughout can also play interoperability, and achieve the function of the dispersed function block. PLC is designed specifically for application in industrial environment, which is an abbreviation for Programmable Logic Controller, is a kind of real-time control device, and also a blend of micro-processing technology, automation technology and communication technology. Its operational principle is shown in Figure 1. In the process of factory automation, not only fieldbus plays a very important role, PLC also has a prominent position, mainly displays in the switch quantity control function and sequence control function. Microelectronics technology is developing rapidly, the computer communication technology also develops in constantly updated, with the development of these two technologies, PLC has also made great progress, the progress is mainly manifested in the hardware configuration, software programming, communications, networking and analog control, etc[4]. In the process of modern production automation, on the basis of PLC and network communication technology, the development of new type of distributed control system has become a major trend. The important way to achieve this kind of distributed control system derived from the fieldbus technology support, research and application of PLC control system.

In modern industrial process control, its main characteristic is to centralized management and decentralized control of the monitor[5]. A typical process control system is based on the support of local area communication network technology, and the network architecture is shown in Figure 2. In this figure, in the Factory level and Device level, Fieldbus and PLC are dominant. Each manufacturer saw the important role of PLC, introduced the PLC special fieldbus products, which is dominated by Modicon company and OMRON company, who introduced a Modbus Plus (MB +) and the Controller Link products, represented by the two products because of its good effect and wide range of application.

Modicon is a subsidiary of Schneider, the industrial local area network it developed for series of PLC product is the Modbus Plus, which has the characteristics of high speed and reciprocity. According to the ISO/OSI reference model, the network system of Modbus Plus includes four layers, respectively for the physical layer, data link layer, session layer and application layer, in the most important data link layer, the information frame consists of four parts. In Modbus Plus network, each node has unique address; between nodes there are mainly three ways to transmit information: master-slave transmission, point-to-point transmission and distributed I/O transmission for remote access and control. Node can change into the shared token circulation of global database information through users. Through the bridge can realize the communication between Modbus Plus network and the network[6]. ZHANG Guangming and others applied Modbus Plus bus technology, developed a two-layer structure computer automatic control system and Modicon series PLC is as the core, the control system is mainly applied in ceramics production line. Ramirez and others combined the distributed I/O control function and the wireless

communication technology of Modbus Plus network to develop remote monitoring and surveillance system, which is applied in grid system to provide a new thought and method for electric power automation.

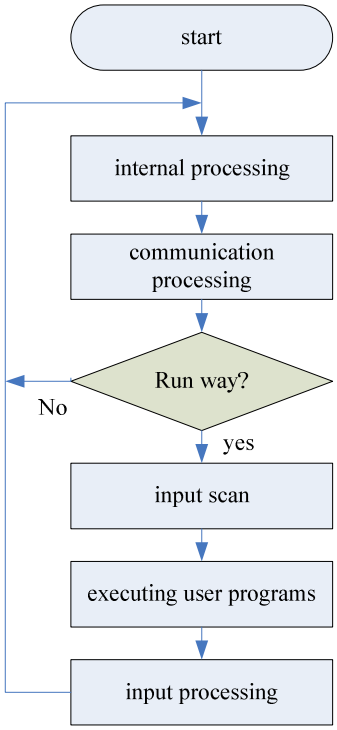


Figure 1 : Operational principle

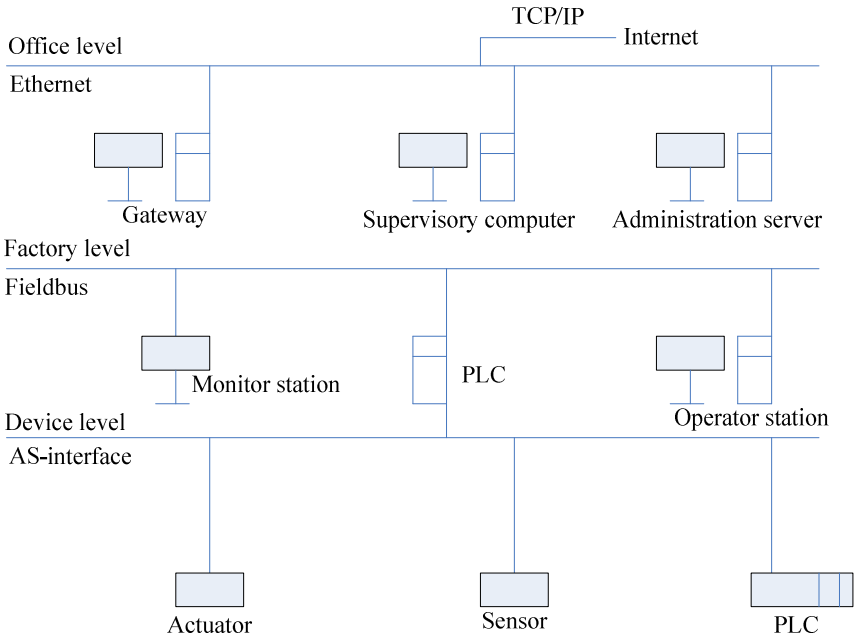


Figure 2 : Network architecture of typical process control system

Controller Link is developed by OMRON Company; it is a kind of token bus network for SYSMAC C series PLC and follows IEEE80214 LAN standards. The product configuration is flexible, PLC is linked by FA network form so that between the PC and PLC can sent and received large capacity data packets. In the process of Controller Link combines Ethernet to build DCS, with unique FINS instructions, it is able to read and control, and also can write the users' program by PLC to send to the PC FINS transfer instruction to proceed with the requested information. In Controller Link, if the Fins Gateway is used in the application layer, the data link also can be managed. In addition, on the Controller Link network, the connection with RS232 or RS485 can through PLC programming and monitoring management and decentralized control, this

function is achieved by CX - Programmer Windows programming software. ZHU Xuejun and others used Controller Link to form the DCS, which is the three-tier architecture with OMRON CS1 series PLC as the center, and applied to the wastewater treatment process. TENG Shengguang and others based on the PLC, combined with the Controller Link to emphatically set up a network protocol macro compiled and this design is used in environmental protection heating engineering application. This paper also lists the performance index of Modbus Plus and Controller Link in application, and the specific index values are shown in TABLE 1.

TABLE 1 : Performance index of modbus plus and controller link

Bus name	Communication rate	Transmission distance	Nodes number	Data capacity	Monitoring software
Controller	2M bps		32	32k	CX-
Link	1M bps	1km			Programmer
Modbus	1M bps	twisted-pair	32	24k	RSV iew32
Plus		0.45km			

PLC CONTROL SYSTEM BASED ON PROFIBUS

Profibus is a kind of international standard (IEC61158) bus, which is an abbreviation for Process Field Bus. It is an open bus jointly developed by a number of research institutions in 1987[7]. After nearly 20 year's development, the application of Profibus bus now is wide in industrial control process.

Profibus follow the ISO/OSI model and is consisted of three layers, namely the physical layer, data link layer and application layer. In the application layer, there are three sub-layers for the application of communication management and the mapping of fieldbus message specification and parameters' transmission. In data link layer, there are three sub-layers for relevant regulation and description, which is in the media transmission connection, according to the bus access method regulated low-level excuse effective service, additionally set the bus parameters. Figure 3 shows schematic diagram of Profibus network protocol based on the OSI model. In practical application, 127 nodes can be linked to Profibus network segment. Transmission rate is different when in the different distance, 200 m and 1200 m for the transmission rate of 500 KBPS and 916 KBPS respectively. As the bus network, Profibus can provide three different series of products to maximally meet the needs of the actual industrial process control. In these 3 kinds of products, the Profibus-DP is for real-time communication; Profibus-FMS is for intermediate-level control and Profibus-PA is dedicated to process automation. Theoretically, the three networks can combine with PLC to build automatic control system, but in practical application, Profibus - FMS for intermediate-level control is being eliminated by Ethernet. Combined with SIMATIC S7-300 PLC, LI Minfeng and others have carried on the 2nd level monitoring network construction, and apply this technology to transform the heavy ion accelerator high-frequency transmitter automatic control system. ZHOU Xiaoping and others collected many kinds of PLC and WinCC configuration software, studied and made a comparison of different methods of the PLC and monitor computer implement of communication.

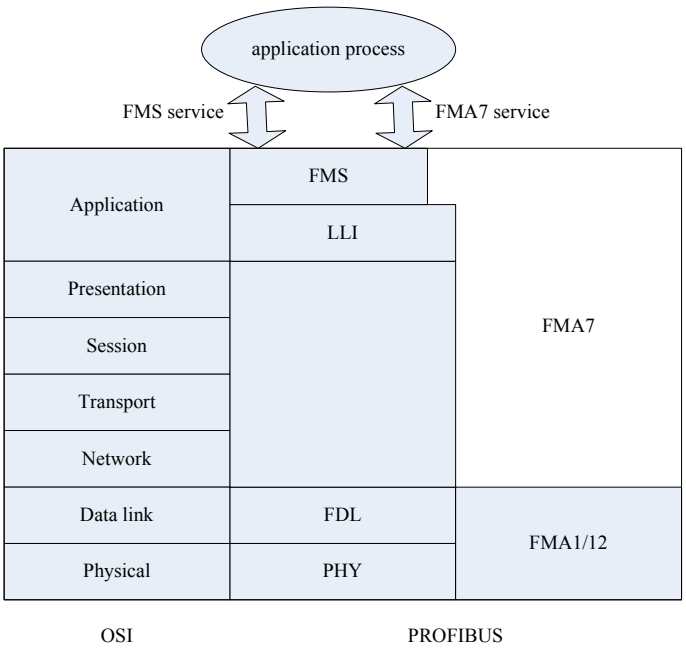


Figure 3 : Schematic diagram of profibus network protocol based on the OSI model

PLC CONTROL SYSTEM BASED ON CAN

CAN is a communication protocol, bidirectional, half-duplex, high-speed serial communication network system put forward by German company BOSCH GmbH, which is an abbreviation for Controller Area Network. After ISO11898 and ISO11519 standardize its communication protocol, CAN become an international standard, which is now widely used in industrial automation. The network composition of CAN and Profibus are similar, both of which are composed of physical layer, data link layer and application layer, except that information frame format, communication mechanism and the system hardware structure, etc.

Figure 4 shows the schematic diagram of CAN network topology. The information transmission medium of CAN is twisted-pair. According to the standard of ISO11898, the network terminal impedance value should be within the scope of 120 Ω + 12 Ω, the transmission rate determines the maximum direct communication distance, in a distance of 40 m and 1000 m, the transmission rate are respectively 1 MBPS and 50 KBPS. Theoretically, 2032 nodes can be linked in a separate CAN network, but in practice, due to the limited hardware facilities, each individual CAN network can only allow to link 110 control nodes. Because CAN uses bus arbitration technique is non-destructive, when the media access, the priority of the node information should be considered. In the process of transmission, the information frame contains four kinds of short frame structure, which has the particularly prominent characteristics of short transfer time and the strong anti-interference ability. QI Yongqing and others based on CAN bus, combined with PLC and hydraulic control technology, established multitasking coordinated control system, and applied to Shanghai maglev project.

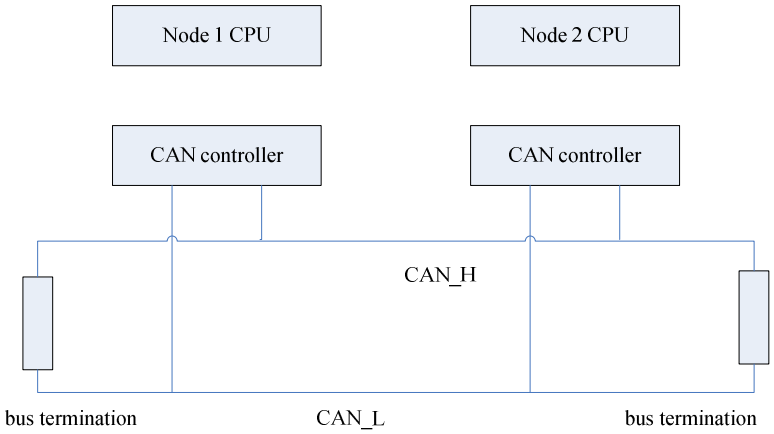


Figure 4 : Schematic diagram of CAN network topology

CONCLUSION

The research and application of fieldbus technology promote the digitalization of distributed control system and network processing, at the same time effectively extending the application space of PLC. With an overall consideration of this paper, PLC communication is special fieldbus represented by Controller Link, which has strong standard of identity. International standard bus, Profibus and CAN, for example, has high degree of openness for control device. The results show that the main development direction of PLC and fieldbus technology are: 1) to expand the interface protocols, add intelligent control algorithm in the application to improve the degree of international standardization of PLC, and to enhance the integration; 2) to apply IP transmission technology and of IKE, strengthen the control of the security of local area network; 3) in order to satisfy the real-time demand of complex control system, to combine with the embedded technology for a more friendly man-machine interface.

ACKNOWLEDGEMENT

Project: The major application of technology innovation project in agriculture in 2013 Shandong province that is *Research on key technology of on-line monitoring and management regulation on soil, fertilizer, water and gas in agriculture based on Internet of things.*

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