Application of CANopen in Servo Motor Control

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Abstract. Compared with other buses, CAN bus has low cost, long data transmission distance and high transmission rate, so it is widely used in the field of automation. In this paper, PLC is used as the master node, CANopen – PROFINET gateway is used as the intermediate node, and the motor driver is used as the slave node. The CAN application layer protocol CANopen realizes the remote control of the driver. Through the debugging of the TIA Portal and CANopen configuration software of Siemens automation tool platform, the conversion and communication of the protocol between PLC and motor controller are realized. At the same time, the process of configuring in three kinds of nodes is introduced. Using this scheme, PLC can easily realize the setting of motor controller parameters, the writing of control commands and the reading of related state quantities, that is, control and detection of motor operation.

Keywords: CAN bus, CANopen -PROFINET gateway, CANopen, PLC.

1. Introduction

CAN is the abbreviation of Controller Area Network. It was developed by BOSCH company, which is famous for developing and producing automotive electronics products, and eventually became the international standard (ISO 11898).

The CAN bus is high performance and Reliability is widely used in the industrial field and is one of the most widely used fieldbuses in the world. The CAN bus protocol only defines the physical layer and data link layer standards. To apply the CAN bus to engineering projects and products, the user must formulate the upper application protocol, which makes the implementation more difficult. In order to solve this problem, CiA has developed a variety of application layer protocols, CANopen protocol is a set of application layer protocols on the underlying protocol of the CAN bus. Figure 1 shows the CAN network structure.

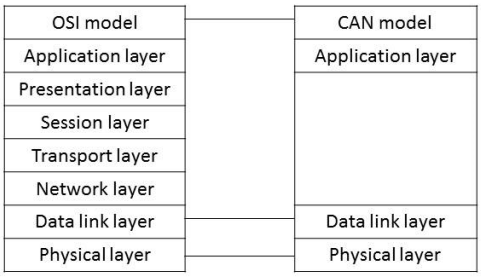

Figure 1.the CAN network structure

As an automated Ethernet standard, PROFINET has four decisive advantages: openness, flexibility, high performance and high efficiency. It has strong adaptability to different levels of security and real-time communication. It can achieve transparent communication between MES and ERP systems. It is also well compatible with existing fieldbus, saves a lot of resources and protects existing investment. As the main controller, Siemens S7-1500 Series High-Performance PLC has fewer CPU ontology support protocols, only supports ProfiBUS and PROFINET.

In order to realize the application of CANopen protocol in PLC and motor driver, this paper takes Siemens 1500 series PLC as the main station, HMS company's CANopen-PROFINET gateway AB7307 as the intermediate node, and Zhuhai Motion Control's PSDA (A9) driver as the slave station.

2. Key Technology

2.1 Implementation Method

A very important part of the CANopen protocol is the device model Which is shown in Figure 2 Device model consists of communication interface, object dictionary and application. The communication interface realizes data transceiver service, and there are four standard communication interfaces. The object dictionary offers interface between the application and the communication and provides access to the device object. The application is a bridge connecting the CANopen slave device to the master station. Since PDO is mainly used in this application, it will be highlighted here.

The PDO provides a direct access channel to the device application object, which is used to transmit real-time short-frame data with a high priority. The transmission of PDO follows the producer/consumer communication mode. The PDO sent by the node device is called the transmitting PDO (TPDO) of the device, and the received PDO is the receiving PDO (RPDO) of the device [9]. Each PDO is described by two objects in the object dictionary: communication parameters and mapping parameters. The PDO communication parameter indicates which COB-ID, transmission type, inhibit time and event time are used; the PDO mapping parameter is used to set the mapping relationship of the data in the PDO message, and determine the location of the data to be transmitted in the CAN message data field.

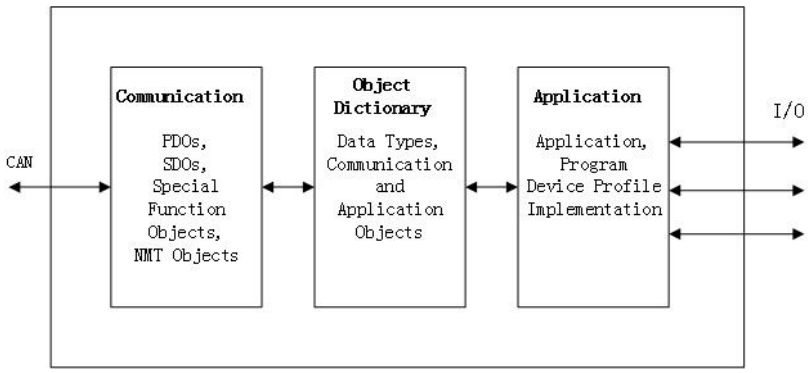

Figure 2. CANopen Device Model

Figure 3 is the Data exchange model, In PROFINET, the PLC acts as the master and the gateway acts as the slave. While in CAN Bus, Gateway acts as master and Drivers act as Slaves. As an intermediate node, the gateway transmits the PLC output data to the corresponding register of the drive according to the configured information, and simultaneously transfers the register data of the drive to the specified position input by the PLC.

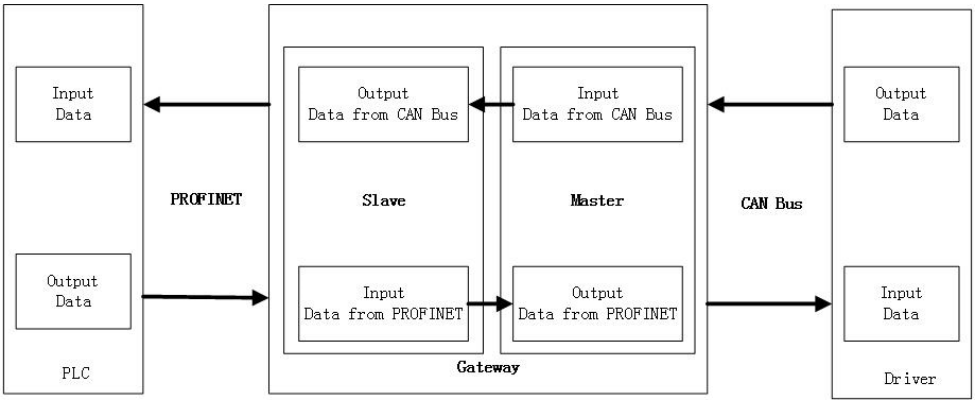

Figure 3. Data exchange model

2.2 Hardware Connection

The list of system hardware is shown in Table 1.

Table 1. four cheme comparing

Name	Model	Quantity
PLC	S7-1516	1
Router	AB7307	1
Driver	PSDA042CA9-N12-M069	4
Servo Motor	60BL(2)B40-30H(ST)	4

System hardware structure diagram shown in Figure 4, Since the upper controller S7-1516 only has PROFINET IO and PROFIBUS DP communication interface, it cannot communicate directly with the motor servo driver via CANopen without a CANopen interface. Therefore, it is necessary to use AB7307 as a gateway to realize the conversion of CANopen to PROFINET. AB7307 connects four motor drivers through CAN bus, and each motor driver controls one motor through cables. SO, in this system, the PLC and the gateway communicate via PROFINET, the gateway and the motor servo controller communicate via CANopen, the gateway implements the conversion function of the two protocols.

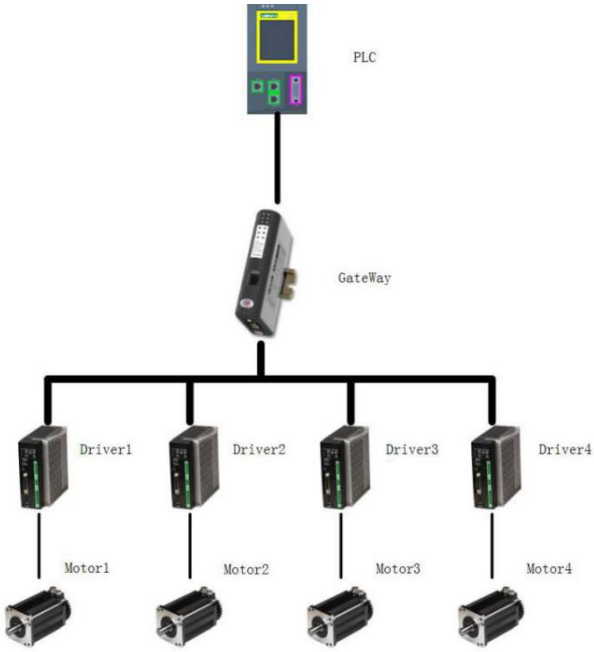

Figure 4. Hardware architecture of the system

2.3 Communication Configuration

2.3.1 Drivers Configuration

The configuration of drivers' side is very simple and convenient. Just set the mode, ID and CanBus baud rate by setting parameters 51,61 and 62 on the driver's panel. The four controller numbers are set to 2, 3, 4, and 5, and the mode and baud rate is set to CAN bus mode and 1 MHz.

2.3.2 Gateway Configuration

There are several steps in the gateway's configuration. These steps using software provided by HMS corporation aim to configure CANopen net and map slaves' register and gateway buffer's addresses.

(1) Connect the drive, gateway and USB to CAN adapter via cable. At the same time, a 120Ω termination resistor is connected across each end. In contrast to the AB7307 manual, place its address to 1, and the baud rate is set to 6, which is 1MHz and consistent with the drives.

(2) Import EDS (Electronic Data Sheet) of AB7307 and drive into the configuration software. EDS files are text files which holds a description of the device and its functions used by network configuration tools to identify products. Click the software scan icon to scan the node. If the EDS files and the physical connection are correct, the scanned node's frame will be green.

(3) Set the AB7307 as a CANopen master and set all four drives as slaves. The producer interval is set to 2000 and the Consuming Node ID/Time Out is set to 3000. Node 1 monitors the heartbeat message sent by slave node every 2000ms. If it is not received within 3000ms, this slave node is considered to be faulty.

(4) This step performs PDO mapping and configures the driver data sent and received by the gateway. First, configure the data sent and received by the gateway, gateway can send three data types, Byte, Word and Double Word. Then Set the synchronization mode to asynchronous. Note that the driver supports up to 8 bytes or four data per TPDO or RPDO, and supports up to 4 TPDO and 4 RPDOs, while the COB-ID is determined by the Node ID.

(5) Set the data size of the gateway in the Object Dictionary. The input and output data size equal the actual number of transmitted data bytes plus 2 bytes, which are the gateway status word and the control word.

(6) Download the configuration to the gateway, then restart it. After that, the configuration is over.

2.3.3 Siemens TIA Portal Configuration PLC Sets AB7307 as a PROFINET IO Slave. There are Five Steps in the Setup Procedure.

(7) Adding the Anybus Device

To include the Anybus X-gateway in the PROFINET network, a GSD (General Station Description) file for the device must be imported into the configuration tool. GSD file was provided by manufacture. After that, drag the Anybus X-gateway module from the hardware catalog into the network view. Then drag some Input and Output modules according to input size and output size we set in the X-gateway.

(8) Assigning I/O addresses

In order to corresponding PLC, I/O addresses and Drivers' register' addresses, we need assign PROFINET device's addresses in TIA Portal. In this project we assign both addresses of 600

(9) Connect PLC and X-gateway

Add a subnet in the PLC internet access we use, then assign X-gateway's subnet the same as the PLC. The port we set needs to be consistent with the port used in reality.

(10) Assigning a Device Name

In order to make PLC clear the device corresponding to GSD file, it's necessary to assign a device name. Right-click on the device and select assigning device name. Then, according to the software guidelines, select the appropriate device name to scan.

(11) Compile and Download

Right-click on the PLC and select compile hardware and software. If there is error, then right-click on the PLC again and select download hardware and software to device. The configuration is over after download.

2.3.4 Programing

Since the PROFINET and CANopen protocol storage patterns are different, PROFINET is big-endian while CANopen is little-endian. It is necessary to implement the conversion of the big-endian and little-endian. This conversion can be realized easily by using the existing instruction Swap in the instruction set, so programing is very simple. Through the scheme adopted in this paper, it is as simple and fast to read and write of the drive's registers as ordinary DI and DO.

3. Result

Through this scheme, the mapping between the IO area of the PLC and the motor register is realized substantially. The No. 2 driver is taken as an example to illustrate the correspondence

between the PLC and the driver through the gateway in the system. Table 2 lists the corresponding input addresses of three devices and Table 3 lists the corresponding output addresses of three devices.

Table 2. Three Devices Addresses Correspondence (Input)

PLC Input Addresses	Gateway Output Buffer	Driver's Registers
IW82	Status Word	None
IW84	RW1	Error Code
IW86	RW2	Status Word
ID88	RD2	Position Actual Valve
ID92	RD3	Velocity Actual Valve
IW96	RW7	Torque Actual Valve

Table 3. Three Devices Addresses Correspondence (Output)

PLC Output Addresses	Gateway Input Buffer	Driver's Registers
QW66	Control Word	None
QB68	TB1	Modes of Operation
QB69	TB2	Homing Method
QW70	TW2	Control Word
QD72	TD2	Target Position
QD76	TD3	Home Offset
QD80	TD4	Profile Velocity
QD84	TD5	Profile Acceleration
QD88	TD6	Profile Deceleration

After completing the link between PLC and servo driver, batch PLC can be connected with PC, which can monitor the operation status of clicks well, and automatically save the relevant information of motor operation status as excell file for reference. At the same time, the motor parameters can be modified by updating the PLC program.

4. Summary

This paper describes the method of conversion between PLC communication protocol and motor controller communication protocol based on CANopen bus protocol, using AB7307 gateway as intermediate node. Using the technology and method described in this paper, through the connection of PLC and frequency converter (servo motor controller), the servo motor can be controlled in real time, and the speed and torque information of the motor can be read, thus realizing the remote control and monitoring of the servo motor. PLC can also be connected with PC to transmit the read information to PC in real time. Staff can directly monitor the operation of the motor through PC. At the same time, the PC can easily write the updated PLC program into the PLC, so the modification and maintenance of the program is also very simple.

Generally speaking, CAN bus has the advantages of low cost and high reliability. According to the method described in this paper, based on CAN open bus protocol, the remote control and monitoring of servo motor can be reliably realized under complex working conditions, which is well adapted to the requirements of high reliability and low cost for automation equipment in factories.

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