Distributed Power Supply Control for SSRF

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Abstract

The project of SSRF (Shanghai Synchrotron Radiation Facility) will be started at the end of 2000[1]. Now it is in the stage of R&D. There are more than 600 magnet power supplies distributed along the storage ring. To control such a large number of magnet power supplies, it's very important to construct a kind of power supply control system with high reliability, good speed and also low cost. After discussion, we decide to design a distributed power supply control system based on CAN-Bus. The magnet power supply controller is composed of an INTEL 80C196KC microprocessor and a PHILIPS 82C200 CAN-Bus interface. It contains 8 bits digital I/O and 4 channels analogue I/O. 16 bit DAC and 16 bit ADC are both selected here. Every digital and analogue I/O for power supply control is optically isolated from the CPU and bus section. The microprocessor receives commands from the upper control computer via CAN-Bus, and then sends signals to the magnet power supply. And it can also take the information from the magnet power supply and pass on to the upper control computer in case of necessity.

1 Introduction

The SSRF is an advanced third generation synchrotron radiation light source including the linac accelerator, the booster, the transport line and the storage ring. It will work at 3.5GeV to serve the synchrotron radiation experiments. According to the requirements, the distributed control system that has been widely used in the world will be adopted in the SSRF. The whole control system has three levels: the central control layer, the subprocessing layer and the device control layer. In the device control layer, the Fieldbus will be chosen for data communication between devices and upper control computer. For the distributed power supply control system, we want to use CAN-Bus. This has the following advantage [2]:

- High reliability. All of the digital and analogue signals are handled right at the power supply controller. And no analogue signals are sent over long wire.
- Multi-master capability. Every controller can send the message to CAN-Bus immediately if necessary. The CSMA/AMP protocol is on silicon.
- Good speed. The maximum speed is 1Mbit/s at a 40m bus length (According to the ISO11898 standard).
- The low cost for controlling per power supply can be achieved. We will use the shielded twisted pair cable to save cost.
- The CAN-Bus is an ISO defined serial communication bus. Compared with the parallel bus, it's easier to install and maintain.

And now we are developing the power supply interface controller module.

2 Architecture

The distributed power supply control system that is based on CAN-Bus belongs to the device control layer [See Fig.1]. And Ethernet (100Mbps) is chosen as the control LAN in the subprocessing layer. This two level control layers are connected by the personal computer or VME (upper control computer) which has the adaptors for Ethernet and CAN. So the Console and File Server computer can communicate with the magnet power supplies. The commands from the console can be sent to the magnet power supplies and the data messages from the magnet power supplies can also be sent to the console and file server. All of the real-time tasks will run on the controller that is plugged into the magnet power supply and links to the CAN-Bus. Only the commands, configuration messages and some necessary information will be sent via the CAN-Bus.

3 Controller

3.1 Hardware Configuration

The distributed power supply control system can support about 100 power supply controllers on one CAN-Bus segment. A functional diagram of the controller is shown in Figure 2. It is based on an INTEL 80C196KC microprocessor, a PHILIPS 82C200 CAN controller and a PHILIPS 82C250 transceiver. The INTEL 80C196KC microprocessor is used to control the magnet power supply and handle the communication with the upper control computer. It provides a Watch-dog timer facility

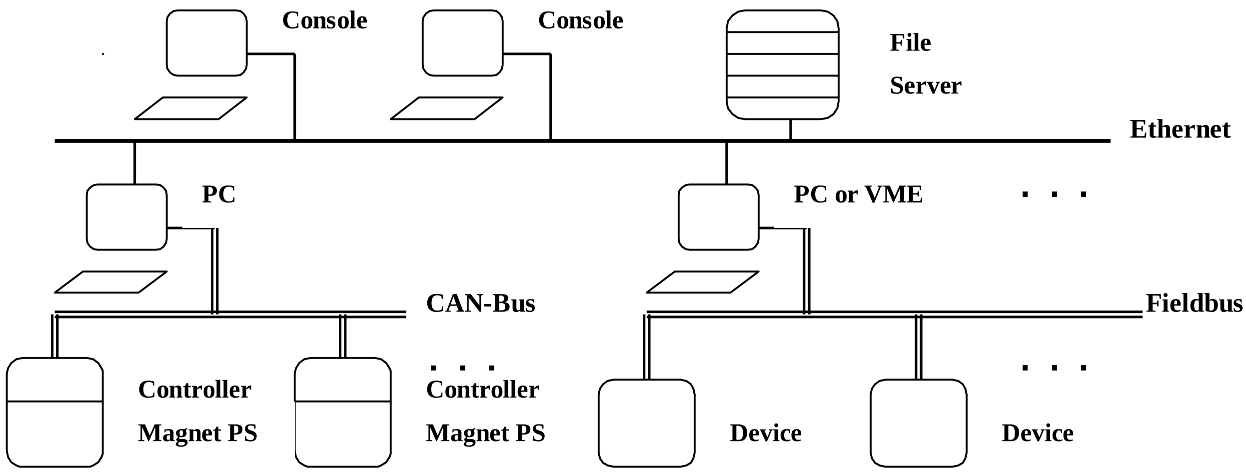

Figure 1: The device layer control system architecture

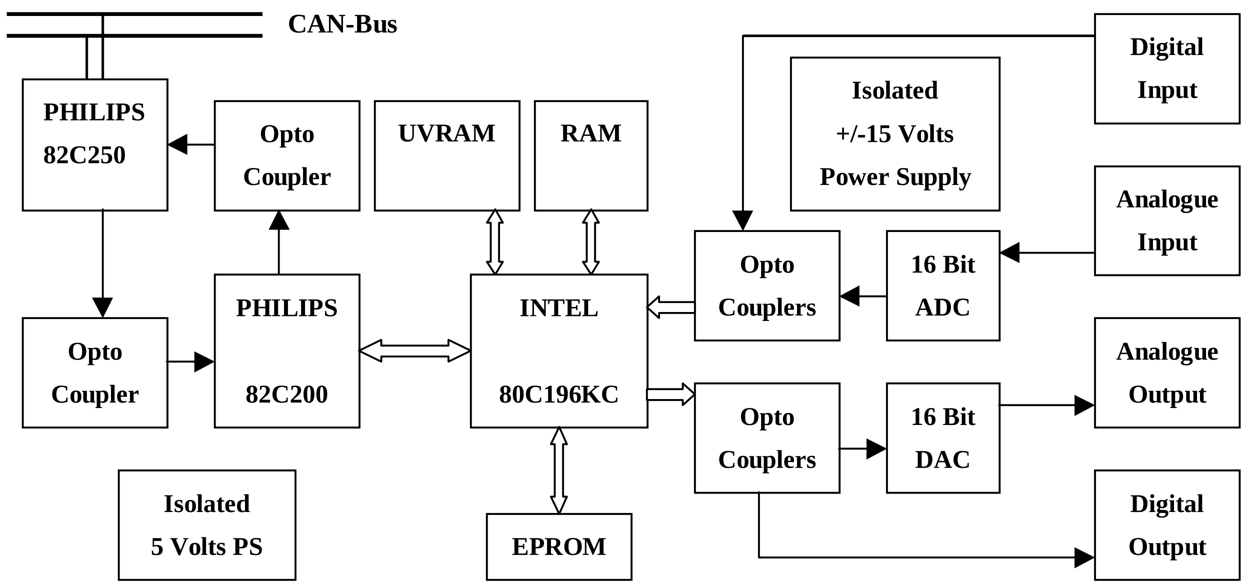

Figure 2: Functional Block Diagram of the power supply controller

for recovering the system from the dead-lock problem. PHILIPS 82C200 and 82C250 deal with the works related with CAN-Bus such as receiving or transmitting data. The NVRAM (non-volatile RAM) is used to store the configuration parameters and some important message. Since the power supply controllers are to be used without any change for all types of magnet power supplies, the number of the digital I/O and analogue I/O should be flexible. So we make every controller contain 8 bits digital I/O and 4 channels analogue I/O. In order to fulfill the demand of high accuracy, 16 bit DAC and 16 bit ADC are both selected here. At the same time, each digital and analogue I/O is optically isolated from the CPU and CAN-Bus section. The power supply status is indicated by LEDs.

3.2 Communication Protocol

The communication protocol mainly depends on the selected CAN controller, PHILIPS 82C200, which fully meets CAN specification 2.0A. Its message frame format is shown in Figure 3. The identifier field contains 11 bits and is used for determining its bus access priority. The priority is defined to be the highest for the smallest binary value of the identifier. And the allocation of priorities to message makes CAN-Bus particularly attractive for use

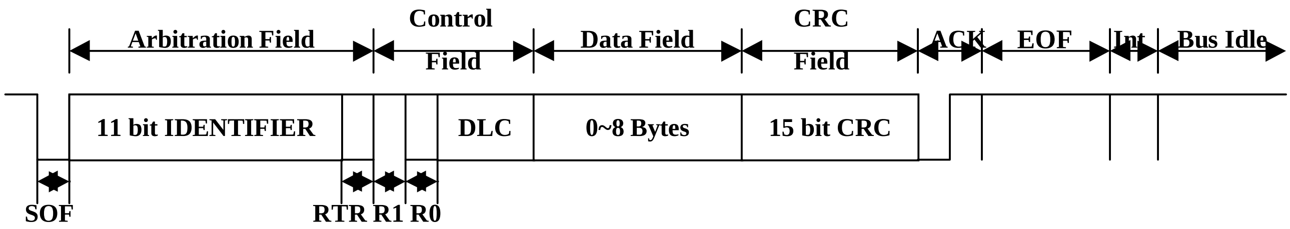

Figure 3: Message Frame Format

within a real-time control environment. The identifier format is shown in Table 1. Bits 2~0 of the identifier field define the message type (See Table 2). The broadcast frame can be received by all of the CAN controllers which are on the same CAN-Bus. In the data field, the first byte defines the destination address.

Bit #	Usage
10	Undefined
9~3	Source address
2~0	Message type

Table 1: CAN-Bus Identifier Format

bit2	1	0	Definition
1	0	X	Single-frame（broadcast）
0	0	X	Single-frame
1	1	1	Unfinished Multi-frame（broadcast）
1	1	0	The Last Multi-frame（broadcast）
0	1	1	Unfinished Multi-frame
0	1	0	The Last Multi-frame

Table 2: Message Type Definition

The application-layer protocol is still being developed now. On power up, the upper control computer that has an adaptor for CAN will send the configuration parameters to the power supply controller through CAN-Bus. From then on, every controller will send its data message to the upper control computer per second. The data message may include the controller status, the DAC values and the ADC values. The controller will keep the power supply in a well-defined status, and run the diagnostic routine to check itself. If the error is fatal, the magnet supply controller will be shut off by itself or by the upper control computer.

4 Conclusion

The SSRF has just been in the stage of R&D. We are designing and developing the power supply control system now. Although we still have not finally determined which kind of Fieldbus will be adopted for SSRF, there is no doubt that CAN-Bus is one of the excellent candidates, and this kind of distributed power supply control system will be one of the good solutions.

5 REFERENCES

[1] “Conceptual Design Report (Draft) of SSRF”, SSRF Working Group, September 1996.

[2] M.Clausen, “CAN & EPICS”, ICALEPCS’97, November 3~7 1997.