# Control system of HLS transport line and Linac focusing power supplies

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**Abstract** The control system of transport line and Linac focusing power supplies of Hefei Light Source was built upon Experimental Physics and Industrial Control System. The hardware construction, software design and performance test of the control system are described.

**Keywords** Control system, Software design

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## 1 INTRODUCTION

Hefei Light Source (HLS) consists of a 200 MeV electron linear accelerator (Linac), a beam transport line, an 800 MeV electron storage ring and the experimental stations. The control system of HLS has been upgraded since 1997. The new control system is built upon Experimental Physics and Industrial Control System (EPICS). EPICS consists of three basic components: Operator Interface (OPI), Input/Output Controller (IOC), and Local Area Network (LAN). Fig.1 shows the structure of EPICS[1].

The transport line power supplies control system and Linac focusing power supplies control system are subsystems of the HLS new control system. They are similar in hardware and software design. An IPC (Industrial Personal Computer) with a Pentium 350 CPU is used as IOC. Several IPCs with a Pentium 233 CPU are used as front-end device controllers (FDCs), which control power supplies with some commercial cards based on Industry Standard Architecture (ISA) bus.

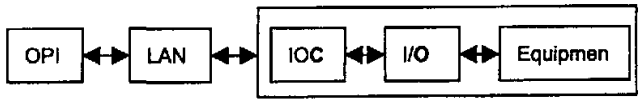


**Fig.1** Basic structure of EPICS

## 2 HARDWARE COMPONENTS

The construction of the transport line P.S.(power supplies) control system and Linac focusing power supplies control system is shown in Fig.2.

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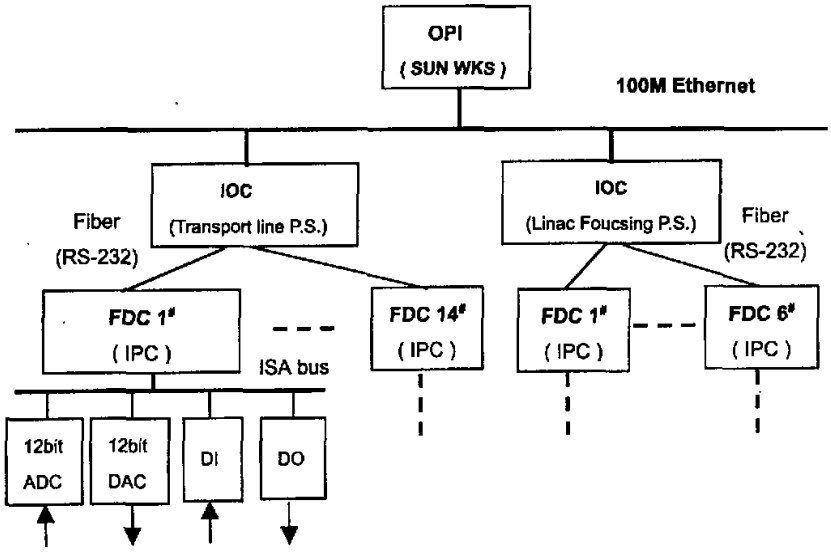


**Fig.2** Construction of the two subsystems

A SUN workstation is used as OPI. There are several windows designed for the man-machine interface with MEDM. The database definitions and EPICS software are also rest on this workstation.

An IPC with a Pentium II 350 CPU is used as IOC. It communicates with FDCs via fiber over RS232C communication protocol. ADAM 4541 modules are used as fiber optic to RS232 converters. A MOXA multi-port RS232 card C168P is used for the IOC to communicate with a group of FDCs. A driver was developed for it and finally the ports are integrated as tty devices.

In order to provide high-speed communication between OPIs and IOCs, 100 M Ethernet is used at the network level. A 100 M Ethernet card is added to the IOC crate to provide an interface between the IOC and the network.

IPCs with Pentium II 233 CPU are used as FDCs. Four types of cards based on ISA bus are used to control the power supplies. A 12-bit DAC card with optical isolators is used to control the set-point value of each power supply. A 12-bit ADC card with optical isolators is used to get the current value of each power supply. A 12-channel relay actuator card is used to turn on/off and reset each power supply. A 16-channel digital input card with optical isolators is used to monitor each power supply status.

The main difference between the transport line power supplies control system and the Linac focusing power supplies control system is the power supplies number and FDC number. In transport line power supplies control system, there are 56 power supplies. Each FDC controls 4 power supplies and there are 14 FDCs in total. In the Linac focusing power supplies control system, there are 42 power supplies. Each FDC controls 7 power supplies, and there are 6 FDCs in all.

## 3 SOFTWARE DESIGN

### 3.1 FDC monitor program

The FDC monitor program is based upon a vxWorks real-time operation system. The functional diagram is shown in Fig.3. The FDC monitor program consists of three parts: communication module, main loop module, and I/O drivers[2].

The main function of communication module is to receive the message from IOC and then check if the message is correct. If correct, a semaphore is given, which will be taken by the main loop module. If the command in the message is a kind of read command, it also has the obligation to send back the response message to IOC.

When a semaphore is given, main loop module takes the semaphore. Then it reads and parses the message. If the command in the message is a kind of write one, main loop module calls the corresponding driver which sets the value from the message to the corresponding channel. If the command is a kind of read one, main loop module calls the corresponding driver to read the corresponding channel and then send back the response message via communication module.

There are several I/O drivers providing a way to access the corresponding hardware channels.

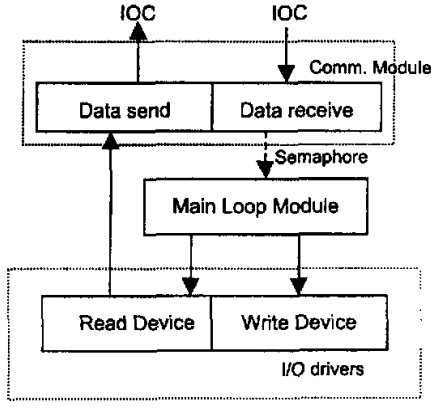


**Fig.3** FDC software functional diagram

### 3.2 Software of IOC and OPI

The heart of each IOC is a memory resident database together with various memory resident structures describing the contents of the database. There are about 300 records resident in the two IOCs. The following record types are used: ai (Analog Input), ao (Analog Output), MbbiDirect (Direct Multi-bit Binary Input), MbboDirect (Direct Multi-bit Output). DCT (Database Configuration Tool) is used to create a real-time database for the IOC, then the Device Support and Device Drivers (if necessary) are written for each kind of record[3].

MEDM (Motif version of combined display manager and display editor) is used to create the control interface. Fig.4 is a part of Linac focusing power supplies control interface..

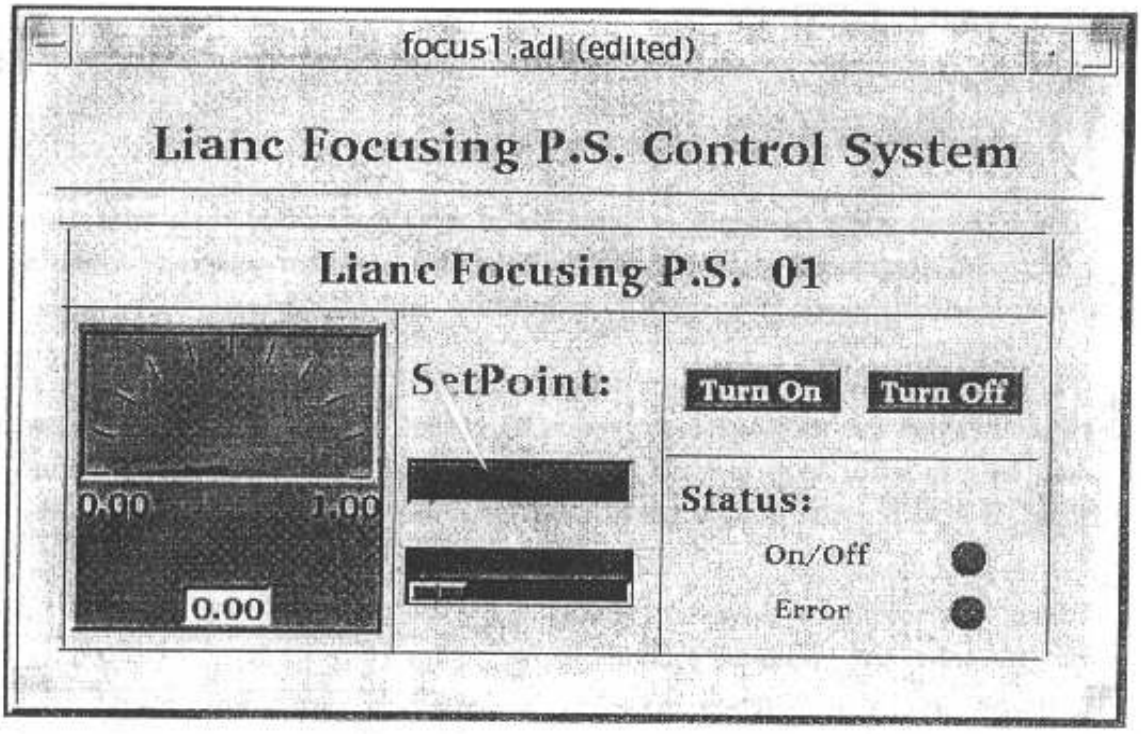


**Fig.4** A part of the Linac focusing power supplies control interface

## 4 Conclusion

The control system of transport line and Linac focusing power supplies is built upon EPICS. EPICS provides a number of tools for creating a control system. This minimizes the need for custom coding and helps ensure uniform operator interfaces. The structure of EPICS is distributed, it has the good extensibility. The test of transport line power supplies control system was completed in Dec.1999, then the development of Linac focusing power supplies control system was easy. The test shows that the control system is reliable, because IPC applies industrial standard and some measures are taken to avoid Electro-Magnetic Interference (EMI), such as fiber is used to communicate messages between the IOC and FDCs.

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