APPLICATION OF PC IN BEPC INTERLOCK SYSTEM

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Abstract

BEPC (Beijing Electron Positron collider) interlock system is based on Programmable Logic Controllers, has been built in order to improve the reliability of personnel safety and interlock functions. One multimedia PC as the host computer, monitors the PLC system. This paper describes the hardware configuration of the PC, the design idea of the application software for the interlock system.

1 INTRODUCTION

The BEPC interlock system has four-level structure:

- the central layer, which manages the interlocks among BES (Beijing Spectrometer), BSRF
- (Beijing Synchrotron Radiation Facility) , LINAC and Storage Ring.
- the system layer, which implements the interlock among the subsystems belong to the system.
- the subsystem layer, which manages the interlock among the equipment in a local control station.
- the equipment layer, which is included in equipment. For example, one power supply for some Q-magnets should not feeds the current and alarm while the magnets lost cooling water.

The hardware of the system is based on OMRON C200H series PLC as shown in Fig. 1.

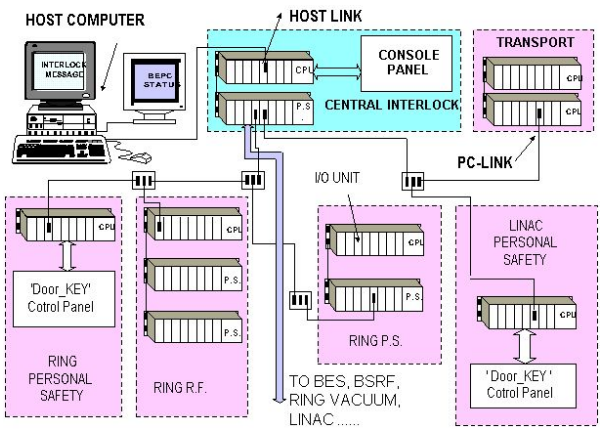

Fig. 1. Layout of the BEPC Interlock System

By means of PC_LINK units, all subsystems are linked to central interlock system with a RS-485 port.

2 CENTRAL INTERLOCK SYSTEM AND ITS HOST COMPUTER

The central interlock system, located in the BEPC control room, is shown in Fig.2. There are two PLC racks of the system. The I/O units are used to connect the operation panel on the console, and a few I/O cardinal signals are connected to subsystems. One multimedia IBM/PC 586 acts as the host computer and monitors the PLC system via a serial port COM2 which is connected to the HOST_LINK mounted in the CPU rack. The PC communicates with the server VAX-4500 and obtains BEPC operation message through a serial port COM3.

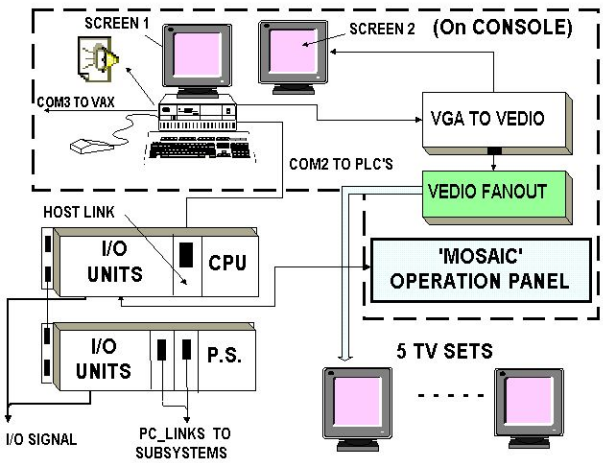

Fig.2. Central Interlock System

Two PC_LINK units, which link all PC_LINK units in PLCs of subsystems with their RS-485 ports, are mounted in the expansion rack. Using an automatic polling method, the '0' level PC_LINK unit exchanges data with PLCs in the storage ring area, the '1' level PC_LINK unit exchanges data with PLCs in the LINAC and Transport Line area. These data are kept in LR (Link Relay) area of the CPU unit. Due to using PC_LINKs, a few cables are used in the interlock system.

The host computer PC is equipped with a Multi-Screen interface card which supports two color monitors. First one is used to show BEPC interlock information and another is used to display the BEPC operation message. The second VGA signal is converted to video signal by

VGA/Video converter and sent to five TV sets at the major entrances via the video fan-out box .

3 SOFTWARE FEATURES ON PC

3.1 The Software Development Environment

MS-Window Chinese V3.2 is selected as the operating system on the host PC, because it provides several major programming capabilities that include standardised graphics user interface, a multitasking capability, an object oriented programming (OOP) approach, memory control and dynamic link libraries (DDLs). To display Chinese characters on screen is also an important reason for this selection. The application software has been developed on the MS Visual C++ workbench. It is an integrated environment that allows user to develop window's applications easily. It provides advanced programming tool kits such as APP STUDIO a graphic editor, APP WIZARD a application template generator, MFC, CLASS WIZARD a class generator and Debugger etc., therefore the software development process can be simplified.

3.2 Application Programs

Easy operation and friendly Man-Machine Interface is design idea of the application programs. The block diagram of the application program is shown in Fig. 3. It consists of following five tasks:

- COM2_PLC Communication is used to fetches the interlock data from the COM2 and update common data pool once per second.

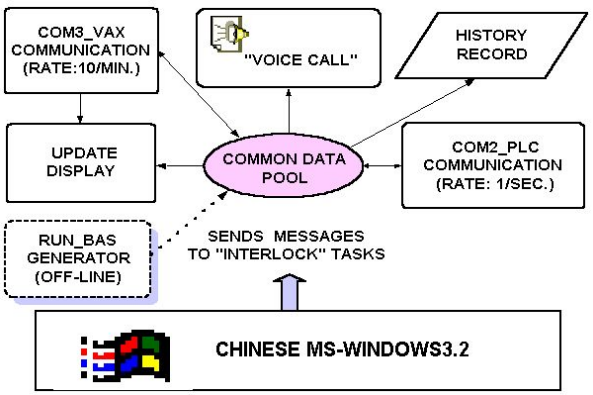

Fig3. Block Diagram of the application

- COM3_VAX Communication gets current beam parameters and operation mode of the Storage Ring from the server VAX-4500 of the BEPC control system.
- Update Display fetches the data from the common data pool and updates two screens.

The initial View on the first screen for the windows application is shown on Fig. 4. Every row of the left column, representing a child window control, consists of one colour icon, one button and one rectangular indicator. Each icon reminds the operator that one child window is pop-up by clicking the mouse on the right button and will show the message of assigned subsystem. Each indicator displays one subsystem's status. The green, red and yellow colour of the indicator indicates fatal failure, secondary failure and normal respectively.

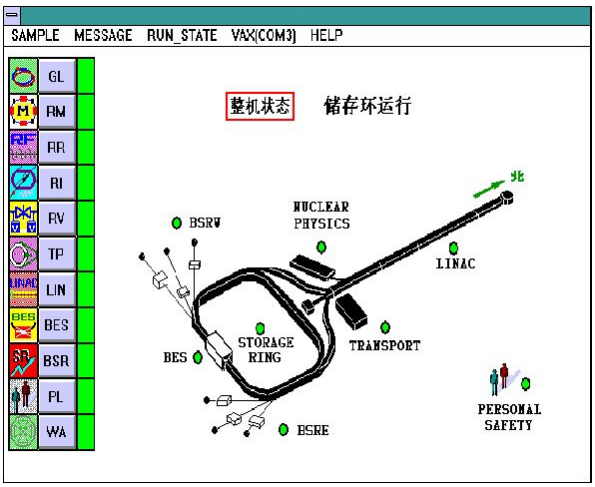

Fig. 4. Initial View on First Screen

The second screen is used to display current BEPC operation message and time as shown in Fig.5. In order to put some short notice on TVs, a edit child window can be opened at the bottom of the screen 2.

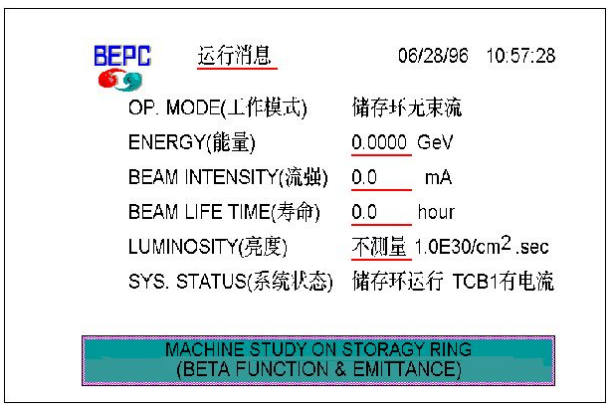

Fig.5. BEPC Operation Message on Second Screen

- History Record records failure status of devices and the failure time .
- Voice Call In case a event or hardware trouble occurs, in addition to the alarm message is displayed on the screens, the Voice Call task plays a waveform sound of the *.wav file which is related to the event. It makes the operator to pay attention and as soon as possible to solve the trouble.

In order to prevent the application from 'dead lock', error tolerance is taken into consideration. For example, If the host computer gets some trouble on its serial port, communication time-out is caused, the program should

pause the communication and the error message should be displayed on screen 1.

3.3 SMALL Database

A small database file RUN_BASE for the application is created and modified by means of a dedicated program RUN_DB.C off-line. When the interlock application starts to run, RUN_BASE file is loaded to the memory. All of the I/O signals in BEPC interlock system are logical signals, but not anolog signals. For convenience of serial communication and data manipulation, the database RUN_BASE as a text file is stored on the hard disc.

RUN_BASE file holds a maximum of 1024 records. According to the features of the PLC and the specific condition of BEPC interlock system, 32-byte is selected as the record length. The data structure of RUN_BASE is shown in Fig. 6.

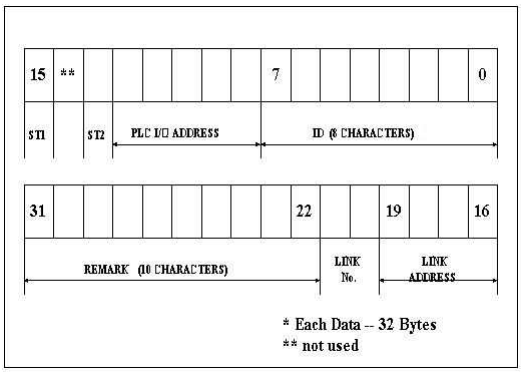

Fig. 6. Data Structure of RUN_BASE

Every record represents a signal. The PLC address field consists of 5 characters, explains the I/O location of the signal in the PLC of central interlock system. The ID field is a signal name, includes 8 characters. The ST1, ST2 are desired and current status. If the signal is a Link Relay (LR) signal, the LINK_No and LINK address should be filled. The remark occupies 10 letters and helps the programmer to know the implication of the signal.

4 CONCLUSION

The BEPC new interlock system was completed by the Control & Instrumentation division and the Radiation Protection division before the end of 1995. Since March 1996, the system has been operational normally. PLC products are very applicable to accelerator's interlock system, due to their reliability, flexibility as well as ease of maintenance. As a result of providing multimedia technology to accelerator control, the operators run the machine easier than before.

The design idea and experiences will be used to upgrade the vacuum local control stations for the Storage Ring of BEPC. The application software will be upgraded on MS-WIN 98 operating system.

As software products are developed at high speed, software tools are becoming increasingly automated, easy-to-use and suitable for customer applications. Besides Visual C++, there are available PC-based tools as well. For example, FoxPro and PowerBuilder for building databases , Fix32 and KingView for supervisory control and data acquisition. So a new control system will implemented more fast than before.

5 ACKNOWLEDGMENT

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