A New Radiation Protection System

Li Juexin Li Yuxiong *Shao Beibei *Wang Ruopeng *Zhang Shidu
National Synchrotron Radiation Laboratory, University Of Science and Technology of China
(Hefei, Anhui 230029, P.R.China)
*Engineering Physics Department, Tsinghua University
(Beijing 100084, P.R.China)

Abstract

The radiation protection system of the National Synchrotron Radiation Laboratory (NSRL) has worked for over eight years since the light source began to run. It guarantees the personal safety for all the operators and experiment members. Most importantly, its control system still has some shortcomings although it works well. Low speed, less storage area, high power consumption and programming difficulty are the main problems. The synchrotron radiation machine has improved continuously along with the science development in recent years. So the radiation protection control system is also facing upgrade. To match the new demands, we have designed another control system with new ideas, up-to-date technology and the most suitable equipment. Its characteristics are much better than the old one and it will not be obsolete in several years.

A 68HC11 series chip-computer and a Pentium PC are used as the local and main controller respectively in the new system. It is an all-in-one control system for safety interlock, area monitoring, environmental monitoring and warning. Its functions can be expanded easily with increased demands. It gives safety priority all along, even if sharing data with central control room.

This paper presents the hardware block diagram, software structure and function explanation of the new radiation protection control system.

2 Shortcomings of the original system

The original radiation protection control system was designed in the middle 1980′s and is based on a lower computer technology level. It worked reliably and met our basic needs in the past years. The faster the technology develops, the more shortcomings it exhibits. It can not satisfy us any more. The main problems are:

- Its heart is a special designed computer (DDL) with an M6809 CPU. It collects area monitoring signals, recieves interlock states, controls a warning box, displays varies parameters and data on LCD, etc. Environmental monitoring is not included. So the whole radiation protection system is separated into two parts.
- The storage area of DDL is not big enough. It has neither hard disk nor floppy disk drive. So the data in RAM cannot be saved on disk. The parameter setting is done in an old way -- by thumb-wheels and key-switch.
- The software of the original system is programmed in FLEX Pascal and 6809 assembler language which are not popular. Only a person who is familiar with 6809 series can program or modify the software kit.
- All the chips in DDL are TTL type and need more power. Once the power supply is interrupted, it does not work. The data stored in RAM will be lost and the parameters have to be reset after resuming running.
- The DDL can not communicate with other computer directly.

What mentioned above cannot be ignored. So the control system must be updated.

3 Composition of the new system

To keep the advantages of the old system as well as match information exchange in the computer network, we selected the local and main controller combination design to update the control system. The chips with excellent characteristics and low-power consumption are used in a local controller. It executes the basic functions. A Pentium PC is the main controller which carries out the data processing and complete software programming for both local and main controller. We do not use the PC to control everything directly for it is not fit for continuous work. It cannot work on batteries for a long time when the power is interrupted. But its high-speed, rich application software and common interfaces provide a powerful tool to realize various data processing and graphics output. To avoid separation, the environmental monitoring system is also controlled by the new system. This is an important difference from the old one. Now the whole radiation protection system is under unified control.

3.1 Structure of the local controller

The main board is a single-board computer with a 68HC11A CPU. It has 128K RAM (can be expanded to 512K when needed) and can store one month of data from 16 channels. It drives a color LCD of 100cm^2 area.

The environmental and area monitoring input units receive signals from 16 channels at the same time. The signals (current pulses) are transfered to the main board after conversion to voltage pulses by these units. As an important effect of the control logic, the interlock state signals from the linac, storage ring and nuclear physics hall are input to the main board through interlock input units.

The Warning unit outputs the warning signal to drive the warning box according to different thresholds.

This local controller can work for one week from a matainence-free battery which is float-charged in normal conditions.

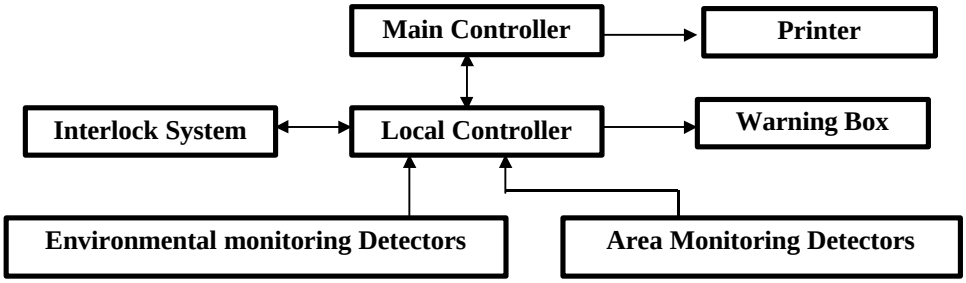

Fig. 1 The diagram of the new system composition.

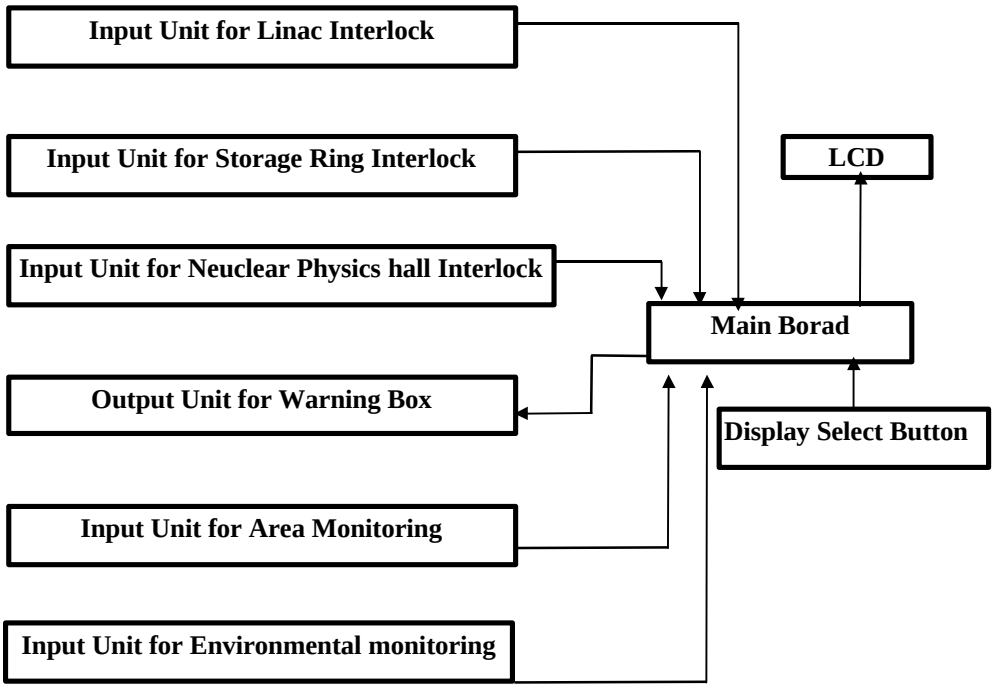

Fig.2 The structure of the lower controller.

3.2 Functions of the local controller

The local controller has more functions than the old one.

- Its time and parameters can be set or reset by the main controller, and the data in RAM can be transferred to PC as well.
- It collectes signals from detectors and stores them in RAM. The collecting interval can be adjusted from 1-10 minutes.
- It calculates dose rate for every channel.
- It provides warning signal for warning box according to the threshold preset.
- The interlock signals are transported from it to PC and then the relative is displayed on the CRT.
- The LCD displays one of following pictures: interlock location diagram, dose rate table for all channels, date and time, etc.

3.3 Main controller and its functions

A Pentium PC is selected as the main controller of the control system. It communicates with the local controller by an RS232 port. The control software is a kit running in the windows environment.

- Data transfer and storage
  The main controller recieves environmental and area monitoring data from the local controller, and saves them on disk as a text file which is easy to open in different application programs. The file begins with the corresponding detector calibrating factor and interval time.
- Data display, dose rate curve or diagram display and output.
  The CRT displays interlock system states and area monitoring results normally.
  The monthly data saved on disk for any channel can be displayed on the screen or printed.
  The dose rate diagram of environmental and area monitoring can be displayed in different colors (to

distinguish bremsstrahlung and neutron). The scale is adjusted automatically. The environmental monitoring result is shown as a curve and the interesting interval can be expanded.

The real-time diagram showed on the screen can be printed.

- Parameters setting

  It adjusts the local controller′s time each time it begins to work.

  The calibrating factor of each detector, time interval and other parameters for the local controller can be set by its relative file. This function is protected by password to prevent illegal modification.

- Calculation

  This function includes:

- The maxim and minimum dose rate among all channels at the specified time;

  The maxim and minimum gamma dose rate among the corresponding channels at the specified time;

  The maxim and minimum neutron doserate among the corresponding channels at the specified time;

  The accumulated injection time and total operation time for the synchrotron light source;

The monthly environmental extra dose recorded by every environmental monitoring station.

These function are seleted by menu.

4 Advantages of the new system

- It controls the entire subsystem at the same time.
- The data processing is done in the PC. It can be completed perfectly due to its rich application software. Data exchange becomes easier than before.
- Since multi-work mode is applied in the local controller′s program, the device works more reliably than before.
- The program can be developed conveniently. We program the software for the local controller in C language in the PC first, then assemble it into 68HC11 assembler language. We can translate it for another system easily when necessary because of the C language′s universal support. So it is a good solution for most programmers and technicians.

The new radiation protection control system has been completed for just several days. It is necessary to check its characteristics according our needs. We will improve it continuously.