PLC-Based Machine Interlock System for PLS 2-GeV Storage Ring

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Abstract

A machine interlock system (MIS) is developed for the Pohang Light Source (PLS) 2-GeV storage ring and is used to prevent machine components from undergoing damages by abnormal machine conditions. The MIS consists of two layers; central PLC layer for data processing and local PLC layer for device scanning and control. The MIS is based on GE-Fanuc-90/70 or 90/30 series programmable logic controllers (PLC). There is a large interlock status display panel in the main control room to display major interlock status information. Application software is developed using Logicmaster90 running on a PC.

1 Introduction

The Pohang Light Source (PLS) 2-GeV storage ring is a third-generation light source that has been under normal operation for beam line users since September 1995[1].

We have developed a machine interlock system (MIS) for the PLS 2-GeV storage ring to prevent machine components from undergoing damages by abnormal machine conditions. The field installation of interlock system was completed in August 1994. After some modification and upgrade works during machine commissioning period from September 1994 to July 1995, the interlock system now works very well to meet our requirement.

The machine interlock system consists of two layers; the central PLC layer for data processing and the local PLC layer for device scanning and control. Major machine components under the supervision of the machine interlock system include magnets, magnet power supplies, vacuum devices, SR injection system, and RF system. Central PLC system is based on GE- Fanuc-90/70 series PLC modules and local PLC system is based on GE-Fanuc-90/70 series PLC modules. Central PLC system is duplicated for fault-tolerant operation. Data network called Genius-Bus between central PLC system and local PLC system is also duplicated. Local PLC units are distributed in local control sheds around storage ring building for distributed control.

There is a large interlock status display panel in the main control room to display major interlock status information. It displays major subsystem interlock information such as beam current, lifetime, subsystem interlock status, linac interlock status, beam line interlock status, etc.

Application software is developed using Logic-master90 running on a PC. We can also monitor or debug the machine interlock system on-line by using Logic-master90. The PC is linked with central PLC system via a RS232C port.

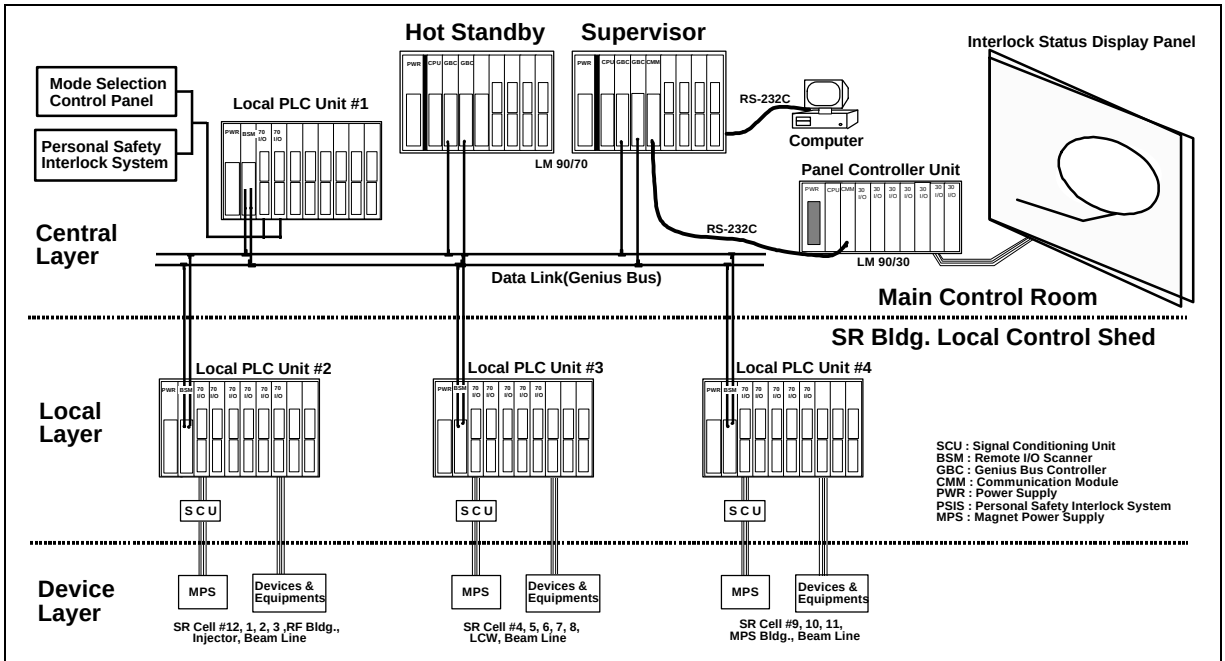

Fig. 1: Configuration Diagram of Machine Interlock System for the PLS 2-GeV storage ring.

2 System configuration and hardware

The machine interlock system (MIS) for the PLS 2-GeV storage ring consists of two layers; central PLC system and local PLS system. There is a large interlock status display panel that displays major machine interlock status information. There is a PC used for application software development and on-line monitoring and control of interlock system. The overall system configuration diagram is shown in Fig. 1.

2.1 Central PLC system

Central PLC system gathers status information of machine components from local PLC system. If any abnormal condition exists, the central PLC system sends out control data to local PLC system that actually generates interlock signals to interlock machine components.

The central PLC system consists of two PLC units; main unit and hot-standby unit. If main PLC unit is out of order, hot standby unit takes over the role of the main one. Main and hot-standby PLC units are implemented with GE-Fanuc-90/70 series PLC modules. The main PLC unit consists of a crate, a power supply module, a CPU module (CPU-771), two Genus-Bus controller modules (BEM731), and a communication module (CMM711). The central PLC system is linked to local PLC system through a data communication network called Genius-Bus. This network is duplicated for fault tolerant operation. BEM731 module is used for Genius-Bus interface. The central PLC unit is linked to a PLC unit via RS232C channel which controls interlock status display panel. CMM711 module is used for RS232C communication interface. The central PLC system is placed in a small room next to the main control room.

2.2 Local PLC system

Local PLC system directly scans machine components attached to it. It has various I/O modules to interface machine components. It sends scanned data to central PLC system via a data network called Genius-Bus. It also sends out interlock signals to machine components according to control data from central PLC system.

Local PLC system consists of 4 PLC units. These unit are based on GE-Fanuc-90/70 series PLC modules. Each of local PLC units consists of a crate, a power supply module, Genius-Bus interface module (BEM731) and some I/O modules. Local PLC unit #1 is used for the control of a small control panel in the main control room by which operator can select operation mode of interlock system. This unit is also interfaced to personal safety interlock system (PSIS). PLC units #2 - #4 are placed in local control sheds around storage ring building and directly connected to machine components.

2.3 Display panel system

There is a large interlock status display panel in the main control room. The panel size is 2.2 meter high and 3.2 meter wide. This panel displays major interlock status

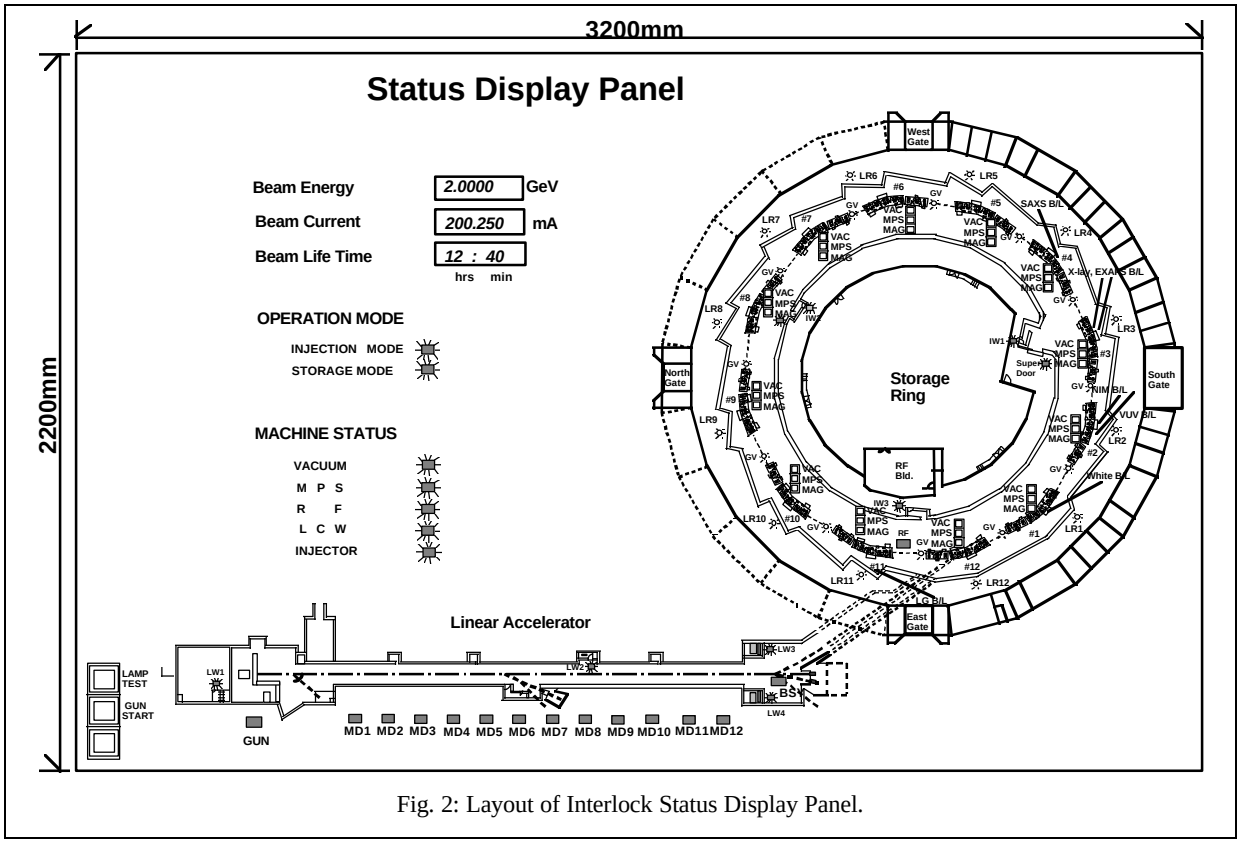

Fig. 2: Layout of Interlock Status Display Panel.

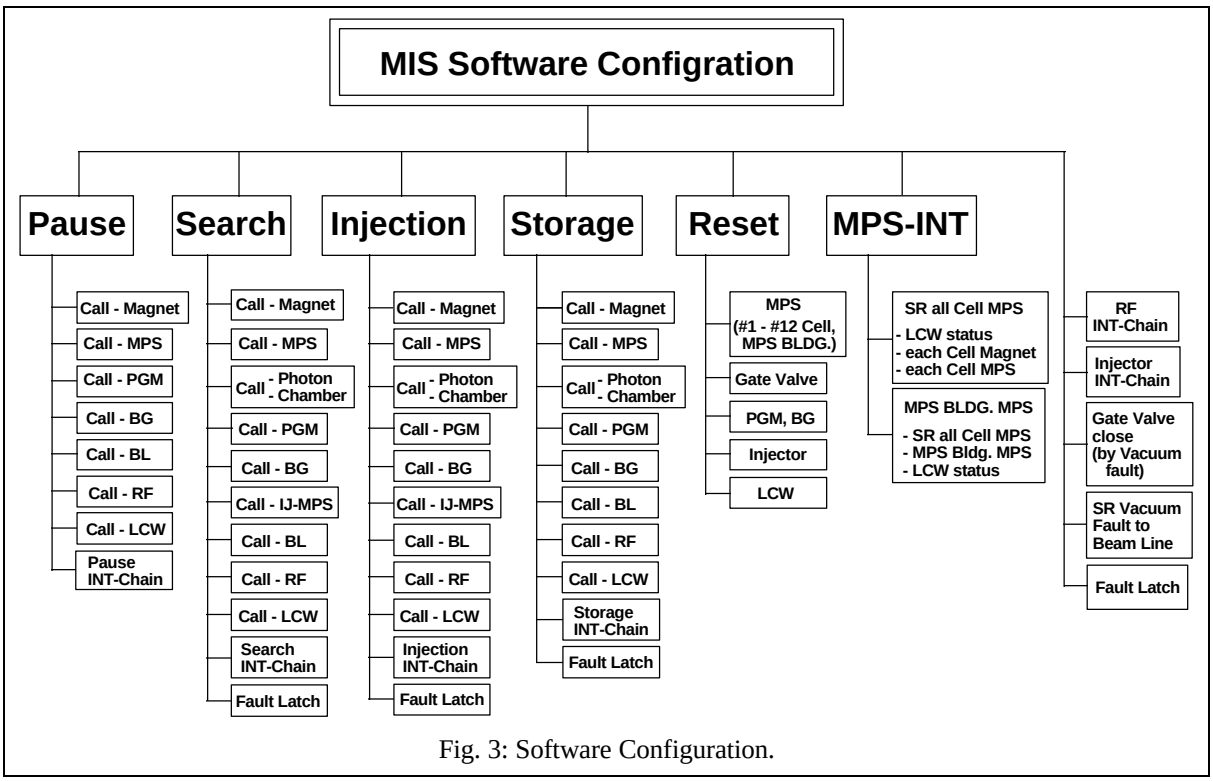

Fig. 3: Software Configuration.

information such as beam current, lifetime, subsystem interlock status, linac interlock status, beam line interlock status, etc. The layout of interlock status display panel is shown in Fig. 2. This panel was built using small mosaic graphic modules for easy panel layout modification and expansion. There is a dedicated PLC controller unit for display panel control. This unit gets needed display information from central PLC system via a RS232C serial communication port. This unit is implemented with GE-Fanuc-90/30 series modules. This unit consists of a crate, a power supply module, a CPU module (CPU311), a communication module (CMM311), and some I/O modules.

2.4 Development PC

We use Logicmaster90 software package running on a PC/Windows-95 to develop application software. This PC is linked to central PLC system via RS232C communication link. We can also monitor and debug interlock system on on-line using Logicmaster90.

3 Software features

3.1 Application software

Application software consists of four blocks; PAUSE, SEARCH, INJECTION, STORAGE, MPS_INT, and RESET. The PAUSE block is activated in machine shut-down or maintenance period. It drives pause mode interlock chain when abnormal machine conditions are detected. The SEARCH block is activated during machine search time. It drives search mode interlock chain. The INJECTION block is activated during beam injection time. This block drives injection mode interlock chain. The STORAGR block is activated when machine is in beam storage mode. It drives storage mode interlock chain. The MPS_INT block is activated when one of PAUSE, SEARCH, and STORAGE blocks drives its interlock chain. The MPS_INT block actually drives interlock signals related with magnet power supplies. The RESET block clears up all interlock signals on pending.

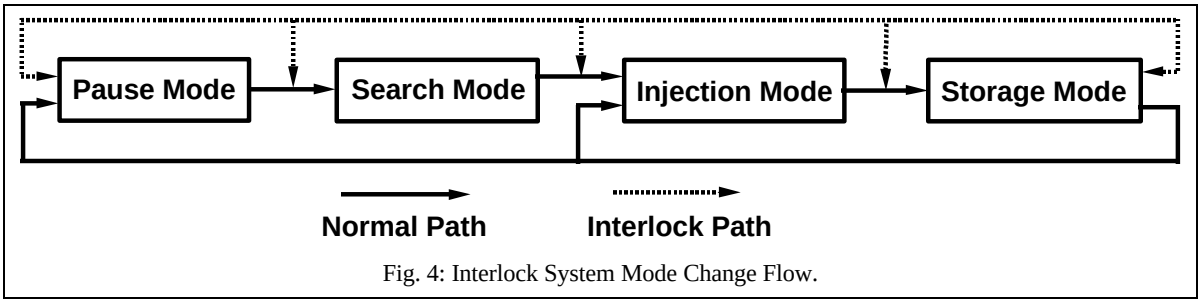

Fig. 4: Interlock System Mode Change Flow.

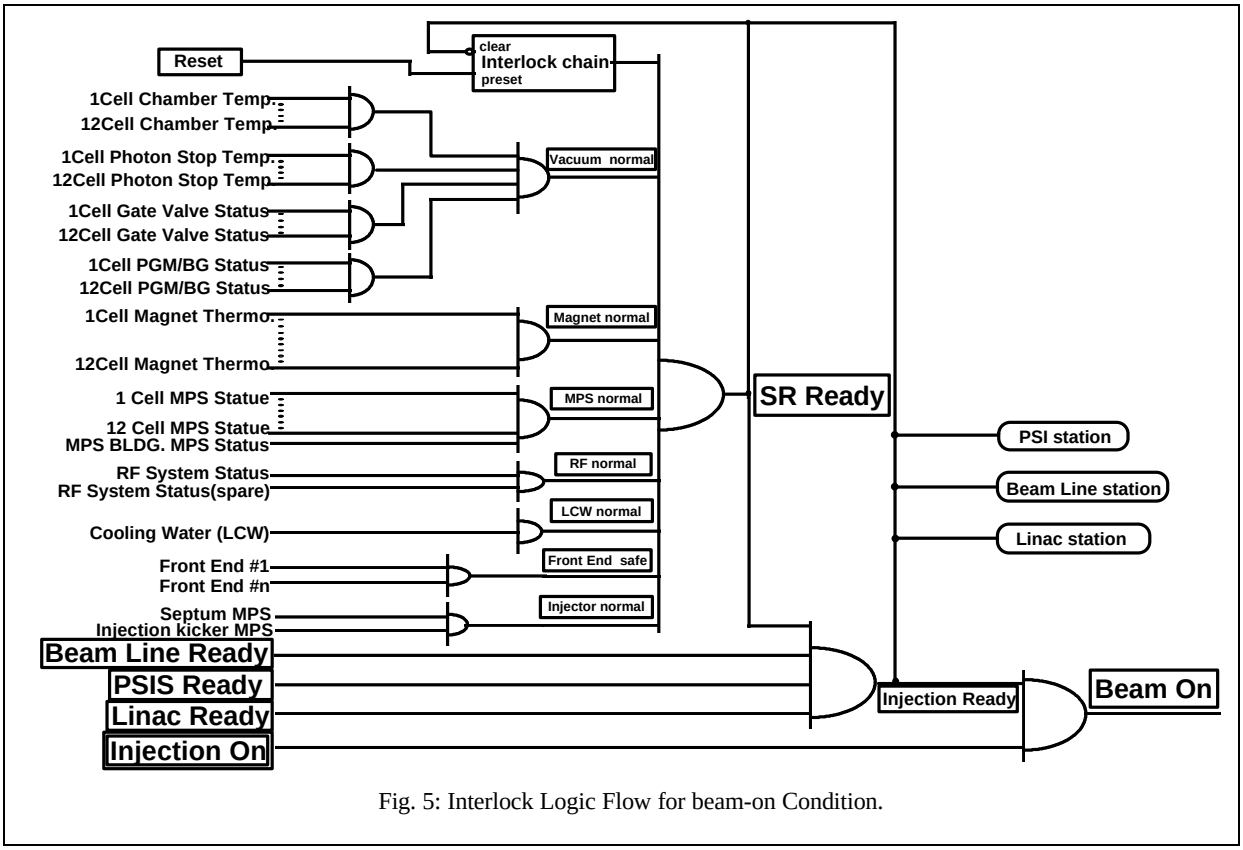

Fig. 5: Interlock Logic Flow for beam-on Condition.

Application software configuration is shown in Fig. 3.

3.2 Operation mode

The machine interlock system is operated in one of four operation modes; pause, search, injection, and storage modes. These modes are selected by the operator by using a control panel placed in the main control room. The operation mode flow of interlock system is shown in Fig. 4, and interlock logic flow for beam-on ready condition is shown in Fig. 5.

The pause mode is selected during machine shut-down or maintenance time. If the pause mode says that the machine is OK, the operator can select the search mode. If the search mode says the machine is OK, the injection mode can be selected. In this mode, the beam injection can be started. If desired beam current is stored in the storage ring, the interlock system goes into storage mode.

4 Conclusion

A PLC-based machine interlock system for PLS 2-GeV storage ring was developed. At initial operation stage, the interlock system was somewhat unstable. To make the system stable, we made some software modification and added some hardware modules. Now, the interlock system shows very stable and reliable operational characteristics.

Acknowledgments

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References

[1] I. S. Ko, et. al., "Control System of PLS 2-GeV Storage Ring," in these proceedings.