Transactions of the Korean Nuclear Society Spring Meeting
Jeju, Korea, May 12-13, 2016

Development of KOMAC Beam Permission System using EPICS framework

Young-Gi Song*, Jae-Ha Kim, Hyeok-Jung Kwon, and Yong-Sub Cho
KOMAC, Korea Atomic Energy Research Institute, Gyeongju 780-904
**Corresponding author: ygsong@kaeri.re.kr*

1. Introduction

The Korea Multi-purpose Accelerator Complex (KOMAC) has two beam extraction points at 20 and 100 MeV for proton beam utilization [1]. The beam extraction from an ion source is with the beam permission system for user and machine protection. The infrastructure of the beam permission system is associated with timing system, personal safety system, machine protection system, and operator permit input. The operation interface of system level signal links is implemented by Experimental Physics and Industrial Control System (EPICS) framework [2]. An EPICS IOC for the beam permit is connected with KOMAC control systems using Channel Access (CA). In this paper, we will describe the infrastructure of EPICS-based IOC configuration for beam permission system and future works.

2. Infrastructure

The KOMAC has three of the major networks. The first is the control network. The control systems for the system level control are distributed on the control network. All the control system is connected by the EPICS CA protocol using Ethernet. The second is a timing network for a synchronized operation. The KOMAC timing system that is based on event distribution system provides synchronization of all the components for the accelerator and the beam lines. The other is an interlock network that is the connection of the interlock systems. The interlock system is to protect the accelerator machine from unstable condition of subsystems. Figure 1 shows a block diagram of the KOMAC networks of control network, timing network, and interlock network.

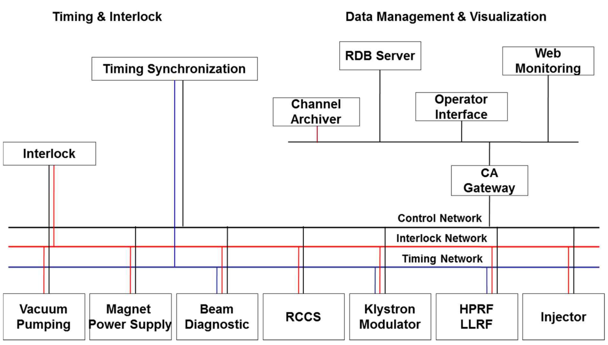

Fig. 1. Block diagram of the KOMAC network; control network, timing network, interlock network

A beam permission system is to protect the machine from an operator's malfunction and subsystem interlock inputs. The beam permit logic references interlock inputs such as Personnel Protection System (PPS), subsystem, and timing system.

3. Interlock monitoring

The interlock inputs of the KOMAC subsystem includes a variety of sources, such as the beam loss, rf arc, power supply faults, gate valve, cooling, and fast closing valves. The system level interlock is hardwired through interlock box. The software interlock monitoring uses an EPICS Input Output Controller (IOC) Process Variables (PV). The beam permission system monitors interlock inputs of the IOCs and hardwired interlock systems. Figure 2 shows a schematic diagram of hardwired and softwired interlock connection [3].

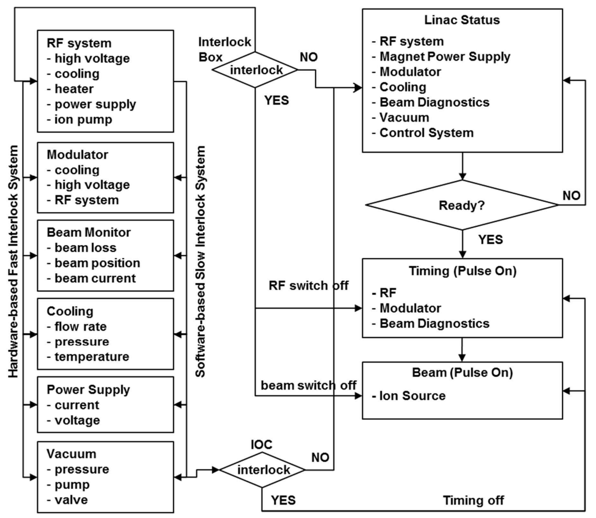

Fig. 2. Flow chart of the interlock system based on a fast interlock system based on hardwired logic and a slow interlock system based on software logic. The beam is stopped by an interlock input. Beam permission is obtained from the hardware and the software based interlock input.

The interlock IOC has sequence logic and records for the beam permission. When a fault of any device or a high radiation level due to the beam losses occurs, first, the interlock box turns off the beam-extraction power supply of the ion source through hardwired interlock logic and turns off the beam within 10 μs. Second, the interlock IOC, which is connected with a timing control system, quickly switches off the next beam pulse by sequence logic for beam permission. If the IOC detects an interlock input of subsystems, a timing trigger for the beam permit is not allowed to the extraction power supply of ion source. The Operator Interface (OPI) displays the alarm status of all the components as shown in Figure 3.

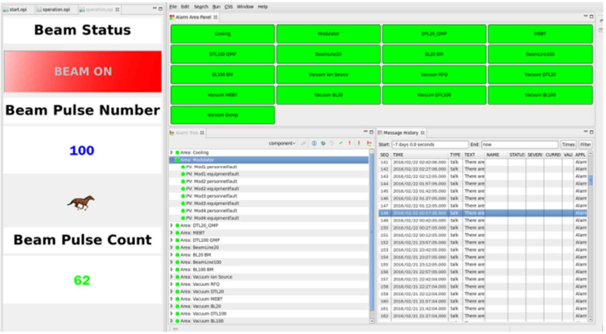

Fig. 3. Main Status of beam pulse and subsystem alarm

4. Beam permission

The beam trigger is permitted by an EPICS sequence logic that monitors interlock inputs of the subsystems including vacuum, power supply status, and beam loss. The beam permission is generated by subsystem inputs of the hardwired and software interlock, and PPS. One of the failures of a critical device, i.e., a failure of personnel safety, or an emergency status in a target room, will activate a beam stop. Figure 4 describes a rough view of the procedure for a beam operation. The beam permission means beam acceleration from ion source to target room. The permission requires the release of all interlock of the linac, personnel safety, target room, and control room.

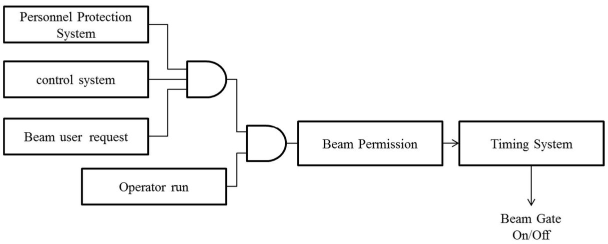

Fig. 4. No run permission for a beam gate without ready signals of linac, Personnel Protection System (PPS), and beam user request.

A beam gate tigger is switched on under no interlock signal of linac subsystem, PPS, user request, and operator run signal. The linac ready condition checks an interlock input of subsystems including RF system, HVCM, beam loss, vacuum, power supply, and cooling. In order to request a beam trigger to timing system, the subsystem should hold with a gate valve open, constant value of power supply, and reliable cooling. In beam service mode, beam user requests beam pulse counts. The beam permit IOC counts the beam pulse. When the beam pulse is equal to user requested pulse, the beam permit system stops the beam pulse.

A beam permit OPI is implemented to monitor user requirements including pulse count and repetition rate and to control the beam permit button. The beam permit button is connected to interlock inputs and PPS. The OPI includes the beam operation parameters for a beam pulse of ion source as shown in Figure 5.

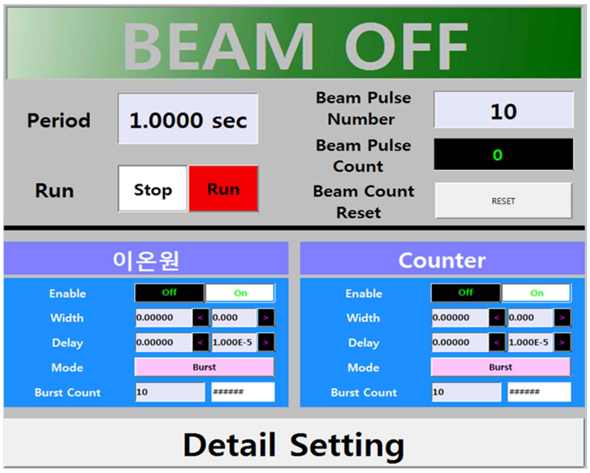

Fig. 5. Operator Interface (OPI) for interlock sequence IOC. Operator controls and monitors beam status using the OPI.

5. Conclusions

A beam permission system was developed to prohibit a beam extraction of ion source. The system references machine interlock signal and PPS. The interlock systems can inhibit a beam whenever one of the control systems detects an error from the local devices. All devices that can affect a beam in the linac machine are so controlled by the interlock system. A beam can be accelerated under machine and personnel protection condition using the beam permission system, which is based on software protection. The beam loss occurs due to the unstable machine. As a result, missing pulse beam on the sample should be compensated. As future work, we will implement a control system to compensate the missing beam pulse automatically.

ACKNOWLEDGMENT

This work was supported by the Ministry of Science, ICT & Future Planning of the Korean Government.

REFERENCES

[1] Yong-Sub Cho, Hyeok-Jung Kwon, Dae-Il Kim, Han-Sung Kim, Jin-YeongRyu, Bum-Sik Park, Kyung-Tae Seol, Young-Gi Song, Sang-Pil Yun, Ji-Ho Jang, "The Komac Accelerator Facility", Proceeding of International Particle Accelerator Conference, Shanghai, China, 2013.
[2] Experimental Physics and Industrial Control System (EPICS). URL:http://www.aps.anl.gov/epics.
[3] Young-Gi Song, J. Korean Phys. Soc. 66, 449 (2015).