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Interlock of Vacuum System for 20MeV DTL

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1. Introduction

Development of a RFQ and DTL for a 20MeV proton beam has been performed at Korea Atomic Energy Research Institute (KAERI),. The proper vacuum components has been installed and operated successfully between ion source and RFQ, DTL. The reliable operation of the accelerator has been completed at vacuum system in the high and ultra high vacuum range under operating conditions. Proper control system between operators and the vacuum instruments for remote control during RF and beam commissioning based on PC and VME operated by Windows, has been designed and constructed. Though each vacuum equipments has simple self- protection circuits, Interlock is required to protect other components

2. VACUUM SYSTEM FOR 20MEV DTL

Vacuum instrumentation at front end and DTL includes valves, gauges, roughing pumps, high vacuum pumps, ultra high vacuum pumps. The layout of vacuum system is presented in Figure 1.[1].

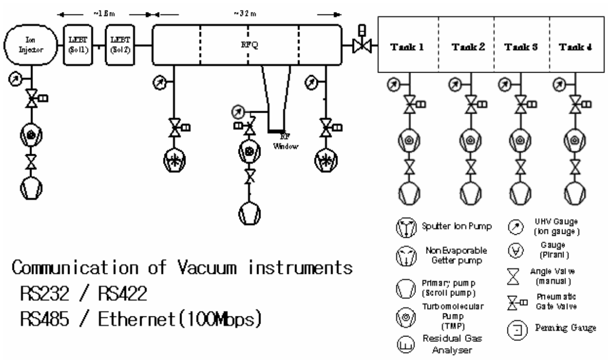

Figure 1. Layout of vacuum system for 20MeV proton beam.

3. INTERLOCK FOR VACUUM SYSTEM

2.1 Interlock condition and response

After turbo pump failure like bearing failure and rotor crash turbo controller will shutdown pump and send fault signal to input output controller (IOC), Interlock should close turbo foreline valve to protect DTL vacuum. In the case of scroll pump failure vacuum gauge monitoring foreline pressure goes up. Interlock should shutdown scroll pump and turbo pump and close turbo foreline valve to protect DTL vacuum. In the case of high pressure or contamination causing RF breakdown vacuum gauge monitoring RF window pressure will send analog value directly to LLRF as hardwire. Extremely large pressure burst will cause interlock to shutdown ion pumps.
Gauge controller will not close the gauge's process control setpoint. Gauge controller may indicate a fault. With redundant gauges and ion pump currents monitoring pressure, interlock is programmed to ignore a single faulty gauge. If interlock system does not read foreline valve position open within a few seconds of energizing solenoid, the turbo pump should be shutdown the solenoid is de-energized and the valve reverts back to its normally closed position.
All interlock status with severity information to alarm operators should be transfer to global control.

2.2 Hardware for interface and interlock

The vacuum instruments are mainly controlled by IOC using OPI consol, while LAN is the communication network which allows the operator interface (OPI) and IOC to communicate.
The interlock is performed at IOC server. Intel P-3 based PC and Power PC based VME system is constructed as IOCs. Linux OS and vxWorks were installed in IOC servers as operating system. Because the most vacuum equipments like turbo pumps, gauges, ion pump, and NEG pump are communicated with serial interface such as RS232, 422, 485 we used serial-to-ethernet converters between vacuum equipments and IOC.

2.2 Software for interface and interlock

ASYN (Communication module)
We use an ASYN module developed as a communication deriver at EPICS community.[2] The ASYN version is asyn-4.1 compiled with base-3.14.6 of the EPICS environment. In the case of the VME system ported modules compiled with tornado 2.2.1 and gcc 3.1at the host work station are operated on the VME as the target system.

Sequencer (Interlock logic module)

We use sequencer of EPICS to implement interlock logic to protect vacuum instruments. The state notation language (SNL) of the sequencer provides a powerful tool for programming sequential operations in a real-time control system like interlock of vacuum system. Based on the simple state transition diagram concepts like vacuum control as shown in figure 2, Sequencer program produced by the state notation language are executed within the framework of the run-time sequencer and transfer interlock information to operators. Seq 2.0 was compiled based on base 3.14.6. In spite of rough interlock condition sequencer loop is stably operated without real vacuum instruments.

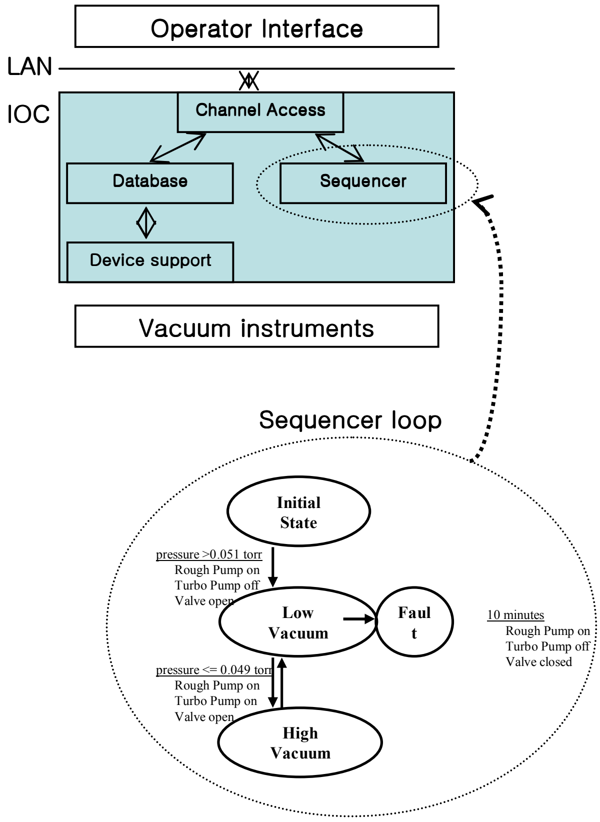

Figure 1. Sequencer layer in EPICS IOC .

Alarm

The Alarm Handler or EDM module of EPICS was used to provide operators with alarming notices. The alarm severity field in an EPICS database record specifies the severity of an alarm state. Currently the alarm severity takes one of the following four values dependent on interlock or vacuum status:

- NO_ALARM: The channel is not in alarm. The pv has returned to a normal vacuum state.
- MINOR: Yellow alarm. This is the lowest alarm severity. Slightly higher than normal vacuum state.
- MAJOR: Red alarm. This is the second highest severity condition. Interlock condition.
- INVALID: White alarm. Invalid data or no communication. This is the highest severity condition.

At typical interlock alarm function is stably operated. Operator has been observed alarming status using alarm handler without real hardware.

4. Conclusion

The interface system to control vacuum instruments of 20MeV DTL has been developed. A control of vacuum system has been focused on remote control such as interface system with vacuum instruments during early commissioning. Recently interlock and alarming function are required to protect equipments of vacuum and others. Sequencer and severity functions were introduced to vacuum EPICS IOC. These modules were compatible to the VME with vxWorks as well as Linux PC. The modular test with real vacuum instruments and code debugging will be performed.

REFERENCES

[1] M. Y. Park, et al, Proceeding of the 2003 Particle Accelerator Conference, p. 2884, 2003.
[2] http://www.aps.anl.gov/epics/