

CONTROL SYSTEM DEVELOPMENT FOR THE KOMAC VACUUM SYSTEM

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Abstract

KAERI (Korea Atomic Energy Research Institute) has been performing the project named KOMAC (Korea Multi-purpose Accelerator Complex). As the 2nd phase of the project, the 20 MeV proton accelerating structure is under development. And for the control system, EPICS (Experimental Physics and Industrial Control System) [1] is adopted. As the first application, we have developed the control system for the vacuum devices using Windows based Personal Computers and EPICS base 3.14.1 [2]. In this paper, we present the structure of the hardware and software we have developed, the results of the test control, and the planned overall scheme for the KOMAC control system.

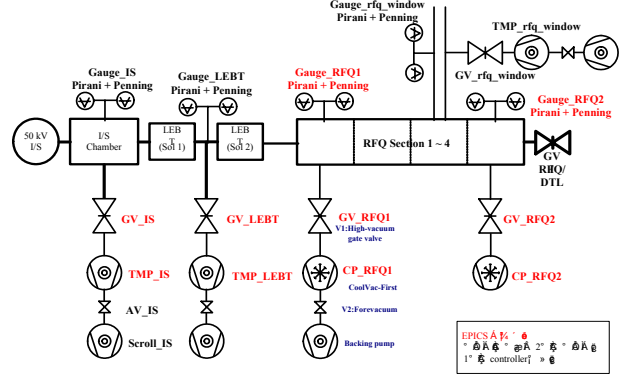
INTRODUCTION

The construction of KOMAC project whose final objective is to build 100 MeV proton accelerator started in 2002 and expected to finish in 2012. In 2005, we expect to have 20mA proton beam of 20MeV. For developing the control systems of the 20 MeV accelerator as well as 100 MeV accelerator, we chose EPICS as the most suitable tool. In the first year of control system development, we studied EPICS applications for various situation and as the first application we developed vacuum control system using EPICS base3.14.1 as the core software.

The KOMAC vacuum control system can be summarized as controlling and/or monitoring cryo-pump, turbo-pump, press gauge, gate valve, and compressor. All these devices are communicating with vacuum IOC (Input Output Controller) through serial connections. And gate valve and turbo pump have their own embedded controlling devices which are connected to IOC through serial connections. Since the real time control is not an issue for serial connections, we chose industrial PC (Personal Computer) as the IOC hardware, and Windows2K as the operating system for convenience.

VACUUM SYSTEM

Figure 1. shows the vacuum system hardware configuration for the 100 MeV proton accelerator. The devices to be controlled by EPICS are 2 cryo-pumps, 4 gate valves, 2 turbo-pumps, and 2 gauges. Since all devices are connected to IOC through serial connections, we chose industrial PC as IOC and RS422 communication as RS422 is relatively safe in wide and noisy environment. Figure 2. shows the EPICS based vacuum control system. The devices and the corresponding communication specifications are listed in Table 1.



The vacuum systems of the PEPF Linac Front End (draft)

Fig 1. Vacuum system hardware configuration

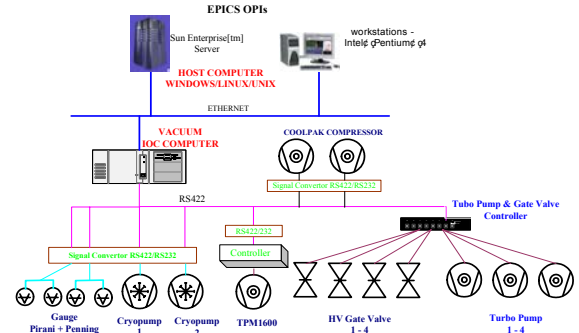


Fig 2. Vacuum control system

Table 1. Devices and their communication specifications

No	Device	Com Port	Communication	Specification
1	cryo Pump-CoolVac First	3	RS233	4800, 1stop, no parity
2	Clyo Pump-SC	4	RS232	9600, 1stop, no parity
3	Turbo pump/Gate valve Controller	5	RS422	115200, 1stop, no party
4	Gauge 1(IT23)	6	RS232	9600, 1stop, no parity
5	Gauge 2(IT23)	7	RS232	"
6	CoolPak-Compressor 1	8	RS232	"
7	CoolPak-Compressor 2	9	RS232	"
8	TURBO PUMP 1600	10	RS232	115200, 1stop, no parity
9	TURBO PUMP 1600	11	RS232	"

Cryo-pump

There are two types in cryo-pumps – old and new model. Even though they are made by the same company, Leybold Vacuum, they have different command sets. We call them CP1 and CP2, respectively. The categories of the commands are (A) Setting commands, (B) Request for Status Information, and (C) Scanned stage temperature readout. And the subcategories of the setting commands are (A1) Setting up operating modes, (A2) Information from the attached system, and (A3) Terminating the REMOTE mode through the serial interface / Reset. One command is consisting of 3 characters and “0x11” is used to identify the beginning and finishing sending the commands. Cryo-pumps are supporting only RS232 communication, we converted it to RS422 using signal converter which will be explained later.

Vacuum Gage Controller

We developed turbo pump and HV gate valve controller. We used the model COMBIVAC IT23/2T and, as can be seen in Figure 1, one gauge is using 2 sensors..

Turbo-pump and Gate Valve Controller

Turbo pump and and gate valve controller is equipped with 115Kbps RS422 ports (4 ports for turbo-pump and 12 ports for gate valve) Turbo pump is performing open/close commands through relay contact point. The status is also monitored through this point. Gate valve becomes open/closed by providing AC220V/60Hz to solenoid. Since turbo pump and gate valve are operated in related mode, the controller is equipped with micro controller which is capable of sequence control. Figure 3 shows the turbo-pump and gate valve controller.

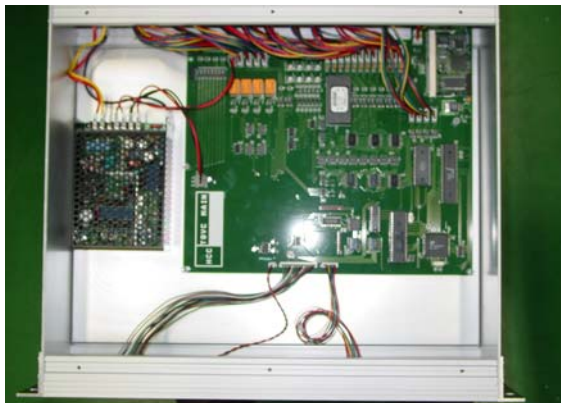


Fig 3. Turbo pump and gate valve controller

Signal Converter

Some vacuum devices supports only RS232 communications whose distances are limited to 15 m. Therefore, we use RS422 supporting IOC and developed Signal converter which converts RS232 signals to RS422. Since RS422 is not only effective at longer distance than 15 m but also very efficient in noisy environment, this

protocol is adopted by almost all industries and accelerators. Figure 4 shows the signal converter.



Fig 4. Signal Converter

EPICS SYSTEM DEVELOPMENT

We chose industrial computer with Windows2K operating system as the EPICS IOC platform since all vacuum devices are connected to IOC via serial communications which do not need fast real time control. Cryo-pumps, pressure gauge, and compressor are directly connected to IOC while embedded controllers are used for the connections for gate valve and turbo pump. IOC software was developed using base 3.14.1 version [1]. In IOC programming, one thread is assigned to each serial port using appropriate structure type. We defined a structure called `iocCommPort` which consists of port number, port name, and device name. By assigning each port number to the thread number, we could simplify the development. Another structure called `sCoolVac_struct`, shown below, is used to share data between device support and target thread.

```
typedef struct      sCoolVac_
{
    double      dbAiVal[MAX_SIGNAL];
    double      dbAoVal[MAX_SIGNAL];
    unsigned char dbBiVal[MAX_SIGNAL];
    unsigned char dbBoVal[MAX_SIGNAL];
    unsigned int dbMbbiVal[MAX_SIGNAL];
    //
    int         signal_no;
    int         coolVacIds;
    int         noTubopump;
    int         noGateValve;
}sCoolVac_struct;
sCoolVac_struct
```

Here, Ai, Ao, Bi, Bo, and Mbbi stand for analog input, analog output, binary input, binary output, and multi byte binary input, respectively. For cryo-pumps, stringin, stringout, ai, bi, mbbi records are used while stringin, stringout, ai, ao, bi, bo records are used for vacuum gauge controller, turbo pump, and gate valve controller.

For the OPI (OPERator Interface), among various extensions [3], we developed control panel using MEDM (Motif Editor Display Manager) as shown in Figure 5.

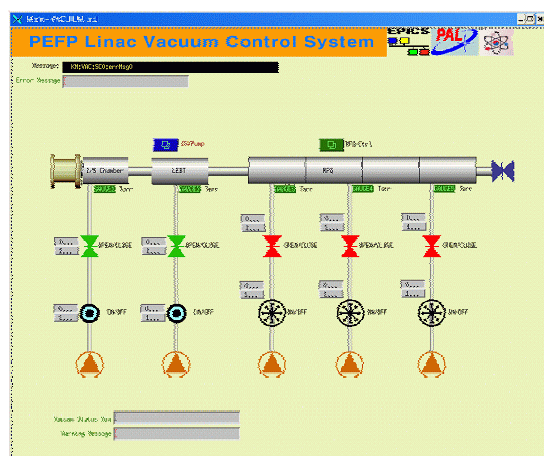


Fig 5. OPI panel for KOMAC vacuum control system

RESULTS

As a result of the KOMAC 1st year project, we developed the vacuum control system. The system was successfully confirmed at the site test. The main tool is PC/Windows based EPICS IOC and Host Extension. The

OPI is programmed using MEDM. During the period, we also performed EPICS application research in various hardware and software environments.

The final output

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- [1] <http://www.aps.anl.gov/epics/modules/base/R3-14/index.php>
- [2] K. Ha, J. Choi, "Control system development for KOMAC vacuum system", KOMAC Report, 2003
- [3] <http://www.aps.anl.gov/epics/extensions/index.php>