Development of the proto type vacuum control system for RAON Accelerator

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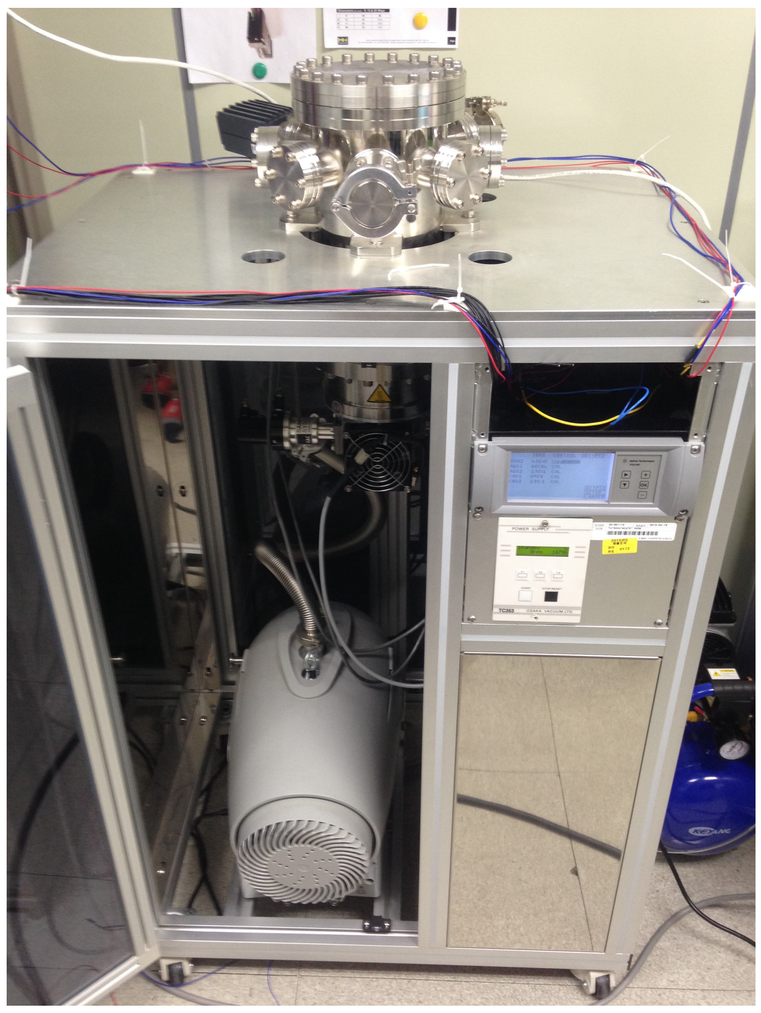
The Rare Isotope Science Project at the Institute for Basic Science constructs a heavy ion accelerator (RAON) facility in South Korea. In order to accelerate the heavy ion beam without beam loss on path of the beam, vacuum system should be designed optimally according to the requirements of each location where are injector, accelerator and experiment system. The interlock logic of the vacuum system should be configured to control each device and to protect them. The interlock logic and sequence to control the system is configured by Programmable Logic Controller (PLC). The PLC system is integrated into Experiment Physics and Industrial Control System (EPICS) for data management. And it's data are monitored with Control System Studio (CSS) as user interface. We performed operating and communication test for each device using demo vacuum control system. The demo vacuum control system is consists of several parts, which are PLC, valves and device controllers. In this report, we will discuss methods to configure EPICS IOC (Input Output Controller) for communication with PLC and CSS. We expect to construct the stable vacuum system of the RAON based on this test experiment.

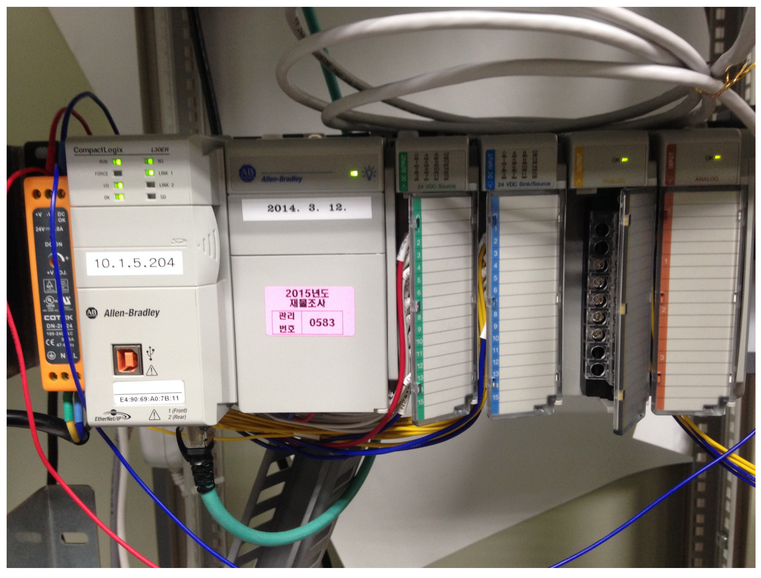
Demo Vacuum Control System



The Demo Vacuum Control system consists of below devices.

- Turbo Molecilar pump (OSAKA TG450FCAB)
- Gauge Controller (XGS-600) & TMP controller (TC-353)
- Convection gauge & FKG-730 gauge
- Gate valve & Angle valve
- Dry pump (IDP-15)

PLC module (Allen-Bradly)



Configuration of the PLC system

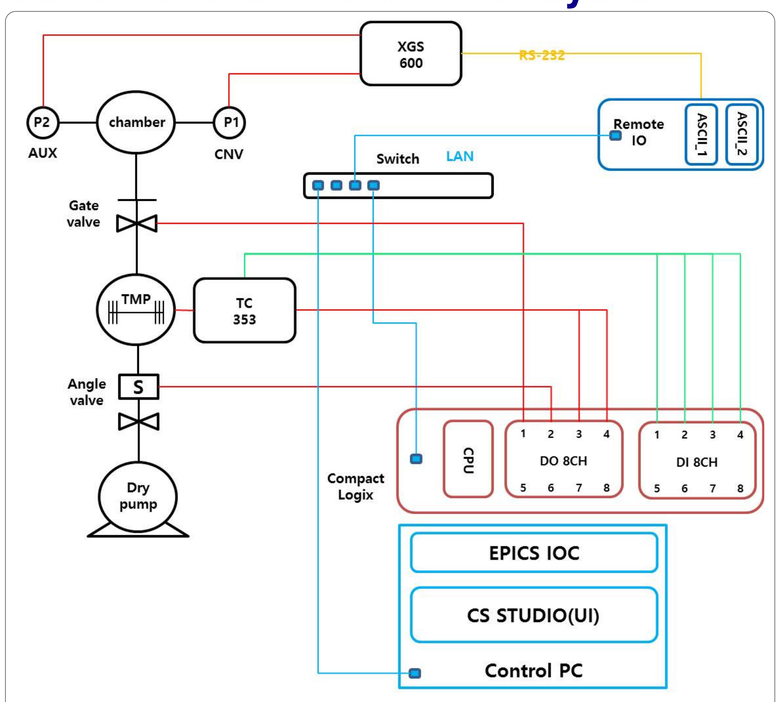
- PLC CPU : L30ER
- Digital Input card : 1769-IQ16 (sink/Source)
- Digital Output card : 1769-OB16
- Analog Input card : 1769-OF2
- Analog Output card : 1769-IF4

Remote IO module

Serial communication modules are installed on remote module.

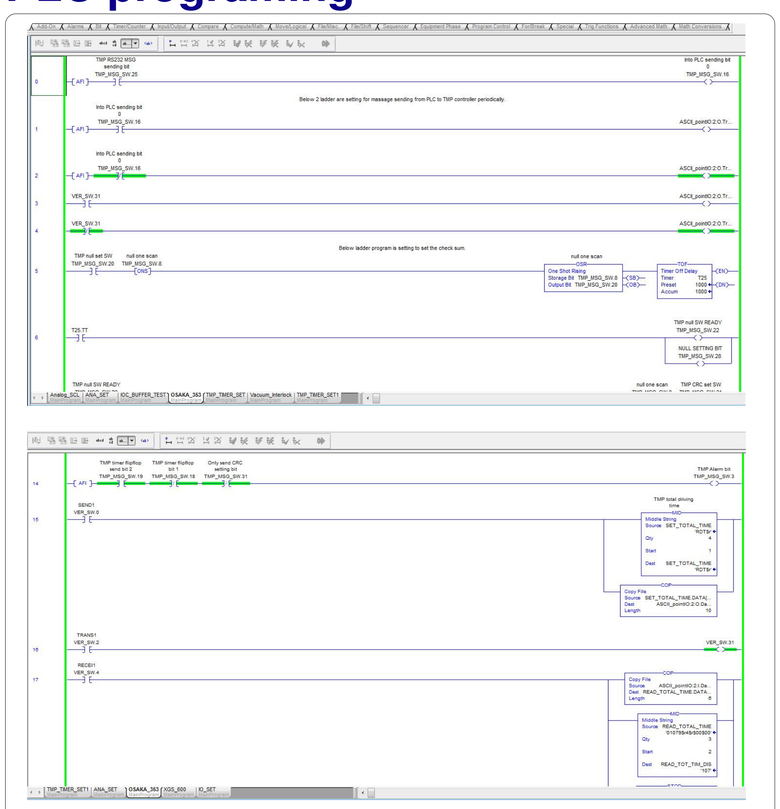
- Remote IO module : 1734-AENT Point IO
- Serial communication card : 1734-232ASC, 2ea

Schematic of the control system



- Vacuum devices are controlled by AB PLC
- RS-232 communication between PLC and XGS-600
- RS-232 communication between PLC and TC-353
- System monitoring by Control System Studio (CSS)

PLC programing



- PLC ladder program to control the all devices and to communicate with device controllers.

EPICS IOC configuration

```
 GNU nano 2.2.6                File: abplcAIA0.db

## Belows are setting for XGS analog signal.

record(ai, "$(IOC):CNV2_READ")
{
        field(DESC, "CNV_GAUGE VALUE")
        field(SCAN, ".1 second")
        field(INP, "@$(PLC) READ_CNV2_FLOAT")
        field(DTYP, "EtherIP")
}

record(ai, "$(IOC):AUX2_READ")
{
        field(DESC, "AUX_GAUGE VALUE")
        field(SCAN, ".1 second")
        field(INP, "@$(PLC) READ_AUX2_FLOAT")
        field(DTYP, "EtherIP")
}


## Belows are setting for OSAKA TMP controller analog signal

record(ai, "$(IOC):TOTAL_TIME1")
{
        field(DESC, "TMP_OPERATING TIME")
        field(SCAN, ".1 second")
        field(INP, "@$(PLC) READ_TIME_DINT")
        field(DTYP, "EtherIP")
}


## Belows are settign to read the analog moudle value of AB PLC.

record(ai, "$(IOC):AI_CH0")
{
        field(DESC, "Channel 0 Input value")
        field(SCAN, ".1 second")
        field(INP, "@$(PLC) Local:4:I.Ch0Data")
        field(DTYP, "EtherIP")

                [ Read 92 lines (Warning: No write permission) ]
^G Get Help  ^O WriteOut  ^R Read File ^Y Prev Page ^K Cut Text  ^C Cur Pos
^X Exit      ^J Justify   ^W Where Is  ^V Next Page ^U UnCut Text ^T To Spell
```

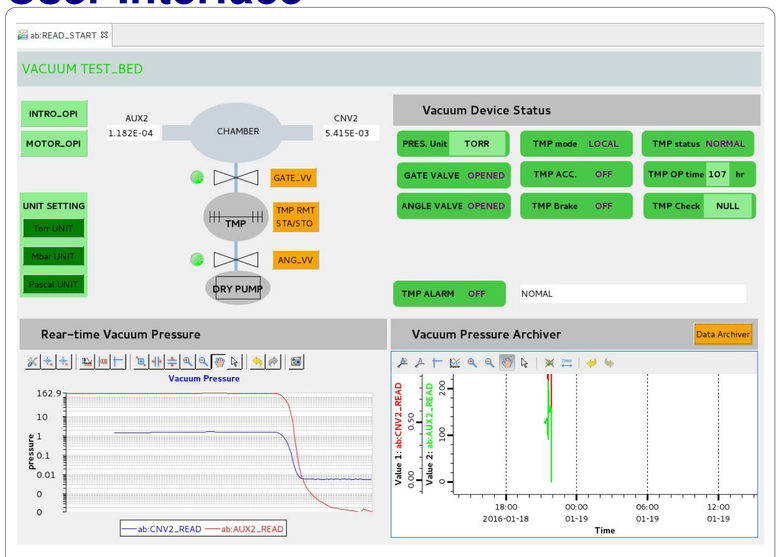
- EPICS IOC database file configuration for matching address between PLC and EPICS PV.

```
 GNU nano 2.2.6                File: st.cmd

#!../../bin/linux-x86_64/ab

## You may have to change ab to something else
## everywhere it appears in this file

< envPaths

cd "${TOP}"

## Register all support components
dbLoadDatabase "dbd/ab.dbd"
ab_registerRecordDeviceDriver pdbbase

EIP_buffer_limit(800)

drvEtherIP_init()

drvEtherIP_define_PLC("AB","10.1.5.204",0)

## Load record instances
## dbLoadRecords("db/plc.db","PLC=AB, IOC=ab")
dbLoadRecords("db/abplcDIDO.db","PLC=AB, IOC=ab")
dbLoadRecords("db/abplcAIAO.db","PLC=AB, IOC=ab")
dbLoadRecords("db/abplcSTRINGIN.db","PLC=AB, IOC=ab")
cd "${TOP}/iocBoot/${IOC}"
iocInit

## Start any sequence programs
#seq sncxxx,"user=hjsonHost"

^G Get Help  ^O WriteOut  ^R Read File ^Y Prev Page ^K Cut Text  ^C Cur Pos
^X Exit      ^J Justify   ^W Where Is  ^V Next Page ^U UnCut Text ^T To Spell
```

- EPICS IOC command file configuration for environment setting to communicate with PLC.

In order to communicate between AB PLC and EPICS IOC, we used the ether-ip module which is released at EPICS homepage (http://www.aps.anl.gov/epics/).

User Interface



- All pressure data could confirm on screen real-time.(lower left)
- All data are archiving on local server in a form text file.(lower right)

Acknowledgement

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