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# VACUUM CONTROL SYSTEM OF SSC-LINAC

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*Abstract*

SSC-Linac is a linear accelerator injector of SSC in HIRFL. The vacuum control system is based on EPICS which is a real-time distributed control software. The Labview real-time VIs and EPICS VIs were used to design Input/Output Controller(IOC). The different kinds of CRIO modules were adopt in device layer, which can monitor the serial port data from vacuum gauges and contol vacuum valves. The whole control system can acquire vacuum data, control vacuum devices remotely, make the pressure value of the vacuum gauge and vacuum valve interlocked. It also keeps the equipment work stable and the beam has a high quality.

## INTRODUCTION

EPICS is a set of Open Source software tools, libraries and applications developed collaboratively and used worldwide to create distributed soft real-time control systems for scientific instruments such as a particle accelerators, telescopes and other large scientific experiments [1]. The OPI(Operator Interface) is based on CSS(Control System Studio). NI cRIO-9022 is used to design the EPICS IOC in this project.

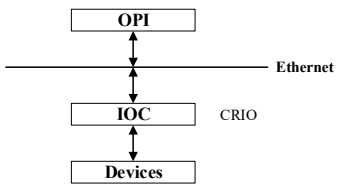


Figure 1: The structure of vacuum control system.

## SOFTWARE

The design includes three sections, which are to receive pressure data from vacuum gauge, to control vacuum valves to be in or to be out, to get the status of vacuum valves. We use FPGA mode to design the program with Labview, because FPGA mode is more stable and faster than SCAN mode [2]. We need an external power supply which has 5V voltage to control vacuum valves. NI provides EPICS modules to write and read data with PVs, The modules support five kinds of data, such as ai, ao, bi, bo and waveform, if you want to define a new type of record, it is forbidden.

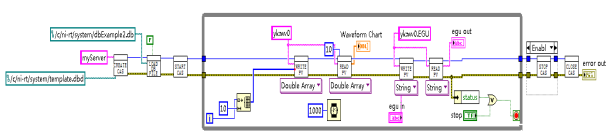

Figure 2: An example of the program.

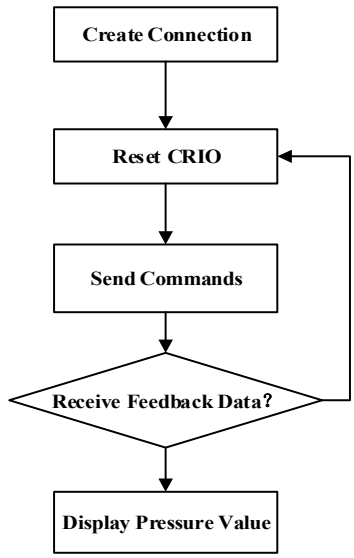


Figure 3: The flow diagram of the design.

Engineering view of this project is shown bellow:

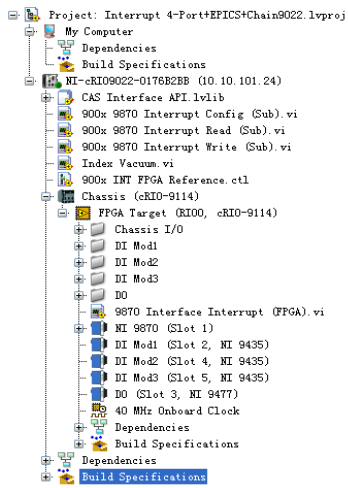


Figure 4: Engineering view.

The project has to set auto running when cRIO is powered on. Users can do it in “Build Specifications” step by step.

## HARDWARE

The interface of vacuum gauge is RS232, DB9, so we use NI-9870 serial module to receive pressure data from vacuum gauges. We use NI-9477 which is a digital output module to control vacuum valves and use NI- 9435 which is a digital input module to get valve status. NI-9870 module can provide 4 serial ports which can link to 4 vacuum gauges. The hardware is shown in figure 4 bellow.

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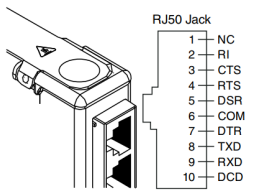


| RJ-50 Pin | Signal Name* |
|---|---|
| 1 | No Connect |
| 2 | RI |
| 3 | CTS |
| 4 | RTS |
| 5 | DSR |
| 6 | GND |
| 7 | DTR |
| 8 | TXD |
| 9 | RXD |
| 10 | DCD |

*These signals are shared by all four RJ-50 connectors on the NI 9870.

Figure 5. NI-9870.

The NI 9870 has four full-featured, independent RS232 DTE ports that are isolated from the other modules in the system. Each port is fully compatible with the ANSI/EIA/TIA-232 standard.

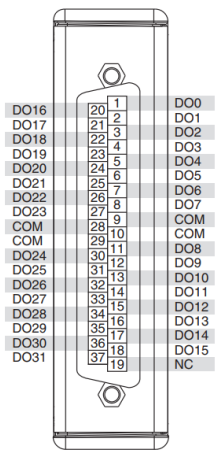


Figure 6. NI-9477.

The NI 9477 is a digital output module for CompactDAQ and CompactRIO systems. Each channel is compatible with 0 V to 60 V signals and features 1,000 Vrms withstand isolation from channel to earth ground. The module can sink up to 625 mA per channel continuous current on all channels and is capable of sinking up to 20 A of current per module (1 A per channel maximum).

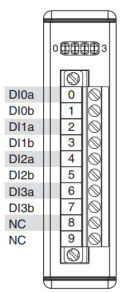


Figure 7. NI-9435.

The NI 9435 has a 10-terminal, detachable screw-terminal connector that provides connections for four digital input channels. Each channel has two terminals, DIa and DIb, to which you can connect voltage signals. The DIa and DIb terminals are interchangeable. The NI 9435 measures whether the difference between the DIa and DIb terminals is greater than or less than the digital logic levels and limits the current flow as needed.

Combine these modules with cRIO-9022, we get all hardware in figure7 shown bellow.

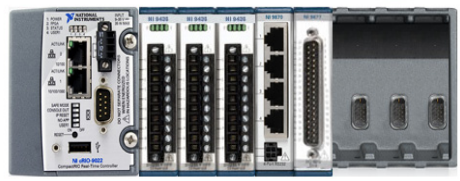

Figure 7. Hardware of the project.

## CONCLUSION

The program has been used for some years in SSC-Linac. It works stable in case of EPICS control structure and NI hardware. The hardware was designed for redundant way in case of adding other digital devices.
NI labview supports only 5 kinds of record, if you want to read or write other PVs which is defined by users own, Labview will fail to do that.

## REFERENCES

[1] http://www.aps.anl.gov/epics/index.php.
[2] Xiaojun Liu, Jianjun Chang etc. “A Method for Vacuum Pressure Acquisition in ECR and Beam Line of SSC-Linac”, Atomic Energy Science and Technology, Vol. 49, Suppl 2015, 604-606.