PLC control system for vacuum and 20 kW RF amplifier

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Abstract

Since 2014, the Sungkyunkwan University has been upgrade 10 MeV cyclotron (SKKUCY-10) prototype for producing radio isotopes. For stable and robust cyclotron operation, local controller is main issue. Especially, RF and Vacuum is main part for control system and each sub system fault result in damage to the other sub systems. To solve those problem, we integrate RF amplifier and vacu-um local controller by LS PLC (Programmable Logic Controllers). Integrated Interlock event is also processed at one controller. This paper describe system requirement for RF amplifier and vacuum and discuss the detailed design and software development by PLC programming at SKKUCY -10.

Architecture of RF AMP and Vacuum system

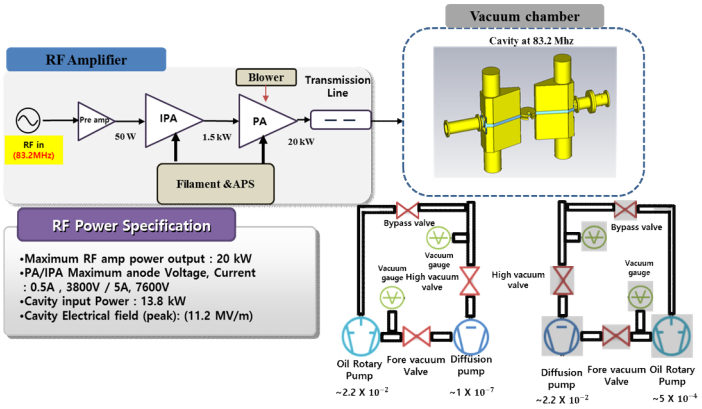

Figure 1. Architecture of RF AMP and Vacuum system

SYSTEM REQUIREMENT

Value	condition	Event
VSWR OVELOAD	PA over Voltage	RF oscillator off
IPA&PA OVERLOAD	IPA & PA Cathode over current	RF oscillator &PA off
PA Water flow status	Flow rate	RF oscillator ,HV off
PA air cooling status	Contact switch off	RF oscillator ,HV off
Pump status 1&2	False	RF oscillator off
Vacuum status	Vacuum level	RF oscillator off
EMERGENCY STOP	Ture	HV off

Table 1.SIGNAL AND CONDITION FOR INTERLOCK

- RF amplifier interlock is considerable parameter for protection from high voltage. Overload parameter from each cathode current and VSWR value is used for major Interlock parameter for amplifier.
- Vacuum level mainly determine state of vacuum system. According to vacuum level and pump states, roughing, foreline and gate valve are operated.
- In our system, we set 5×10^{-6} Torr in SKKUCY-10 vacuum chamber as RF amp operation start-up conditions.
- To Integrated operating procedure realization. Periodic check for interlock condition and machine states are required

SYSTEM Hardware configuration

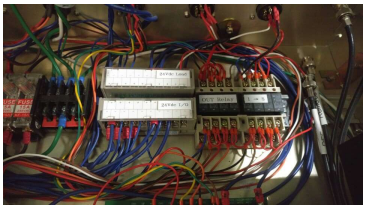

Figure 2. VSWR board for VSWR OVERLOAD

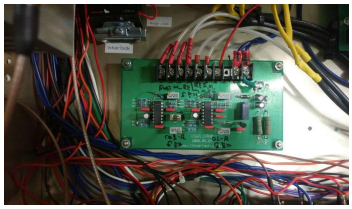

Figure 3. Relay and 24 V dc I/O from PLC

- . To detect VSWR overload its op amp circuit compare Voltage from direction coupler with reference voltage.
- VSWR board output consist of digital output to indicate VSWR interlock and RF detector voltage that is adjusted to PLC voltage input module range.

Software implement

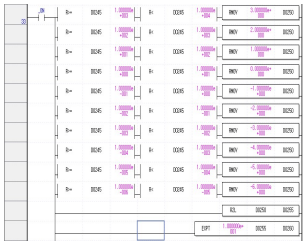

Figure 4. Ladder diagram of Vacuum pressure calibration

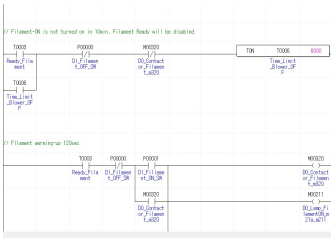

Figure 5. Ladder diagram of vacuum tube ON sequences

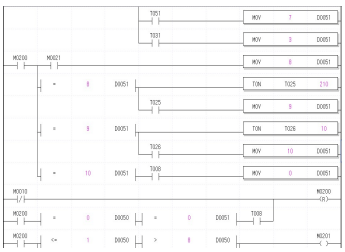

Figure 6. Ladder diagram of auto operation mode

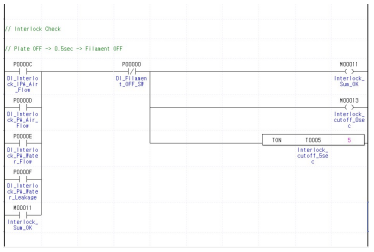

Figure 7. Ladder diagram of Interlock check

- The XGB series PLC was used and its main unit is XBC-DN64H.
- PLC Main unit is used to realize sequence and interlock function of controller.
- XBF-AD04A is analogue voltage and current input module.
- Its voltage input range is from 0 V to 10 V and current input range is 0 ~ 20 mA.
- Digital input and output variables is mainly used for auto operation code

Figure 8.HMI for AMP & Vacuum control

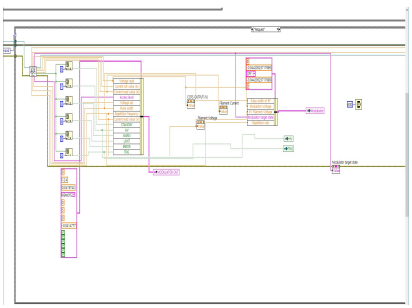

Figure 9. Labview block diagram for communication for PLC

- Realization of Human Machine Interface (HMI) is based on producer/consumer design pattern
- LS PLC Modbus TCP/IP protocol was used for communi-cation between LS PLC and main control platform (NI – Compact RIO)

DISCUSSION

In this paper, integrated Vacuum and RF amp local controller has been presented. Integrated Controller provide automated process for amp and vacuum machine by PLC Interlock function also realized by using plc module. HMI for integrated controller is also developed using LABVIEW 2014. Its HMI and integrated controller will be replaced from original two independent controller for machine stability and management of interlock. Development of integrated controller will be continuously expand to Low level RF controller.

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