SNS RING HIGH POWER RF CONTROL SYSTEM

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ABSTRACT

The SNS Ring RF system is a dual harmonic system. Three cavities running with the harmonic h=1 provide 40kV and one cavity with the harmonic h=2 provide 20 kV. Each cavity has two gaps with a design voltage of 10 kV per gap and will be driven by a power amplifier (PA). An Allen-Bradley ControlLogix is chosen for SNS Ring High Power RF (HPRF) controls via Flex I/O interface over the Remote I/O (RIO) network. The details of the system are presented in this paper.

INTRODUCTION

The Spallation Neutron Source (SNS) consists of a linear accelerator, accumulator ring, and mercury target [1]. The linear accelerator produces 1 GeV H^- beam. The accumulation ring has circumference of 248 meters that is designed to accumulate $2x10^{14}$ protons (about 1000 turns) in 1 ms. After accumulation, the beam is extracted using a fast kicker magnet and send to the mercury target. The main purpose of the HPRF system for the SNS ring is to capture proton beam during 1 ms injection from the 1GeV linac and to maintain a 250 ns gap for the rise time of the extraction kicker.

SYSTEM ARCHITECTURE

The SNS RF system consists of four cavities, three of them are operating on the fundamental and one on the second harmonic, with the rotation frequency being 1.058 MHz [2]. The RF system parameters are shown in Table 1. Each RF system consists of RF power amplifier, bunching cavity, cavity dynamic tuning supply, anode supply rack, capacitor bank, filament supply rack and filament isolation transformer [3].

Parameter	**Value**
Circumference	248 m
Total h=1 voltage	40 kV
Total h=2 voltage	20 kV
Space charge Z/n	i200 Ω
Proton kinetic energy	1Gev
Injection bunch length	610 ns
Injection energy spread	+/- 3.8 MeV, full
Protons at extraction time	2.08×10^{14}
Maximum bunch length	650 ns
Peak beam current	75 Amps

Table 1: System Parameters

SNS is managed by UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy. SNS is a collaboration of six US National Laboratories: Argonne National Laboratory (ANL), Brookhaven National Laboratory (BNL), Thomas Jefferson National Accelerator Facility (TJNAF), Los Alamos National Laboratory (LANL), Lawrence Berkeley National Laboratory (LBNL), and Oak Ridge National Laboratory (ORNL).

The system has three layers of hierarchical structure: device interface layer, central control layer, and operator interface layer (Figure 1).

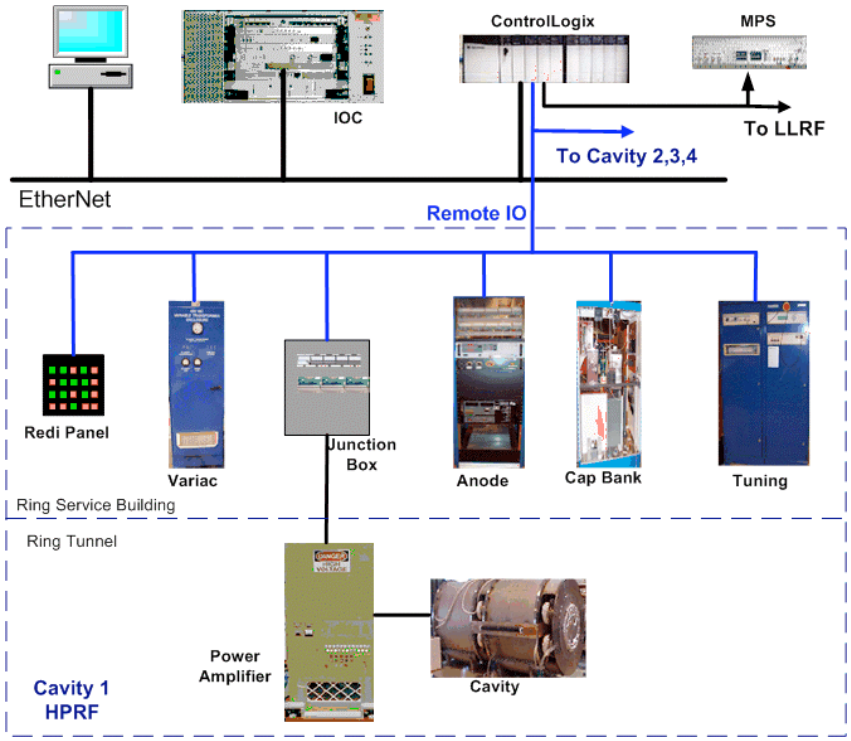

Figure 1: SNS Ring HPRF Control System Layout

Device interface

An Allen-Bradley ControlLogix (CLX) is chosen for SNS Ring High Power RF controls, for SNS selected CLX as the standard PLC. Allen-Bradley Flex I/O and Block I/O are used to reduce the costs. Using the Remote I/O (RIO) functionality, 2 1756-DHRIO channels for 4 cavities in scanner mode transfer discrete and block-transfer data with remote I/O and block I/O devices: Junction Box with cavity signal connection, Filament supply, Anode supply, Capacitor Bank, Dynamic Tuning supply and RF Drive. DHRIO module has two dedicated RIO ports, each bus controls two HPRF systems. A 1756-OG16 TTL level output module is adopted to generate the "RF System Ready" input signal for each cavity to Low Level RF (LLRF) control system and Machine Protection System (MPS).

Central Control interface -IOC

The Input/Output Controller (IOC) is a VME controller to provide the interface between PLC and the operator interface. The system is developed using EPICS toolkit. EPICS application databases are created with SNS standard PV (process variable) name, the PVs are used to generate alarm signals and also for EPICS Archive tool.

The interface between IOC and CLX PLC is over Ethernet using EPICS Ether/IP driver [4].

OPI – Operator Interface layer

EDM as a SNS standard tool is chosen to provide friendly, efficient interface for the Operators (Figure 2). Subsystem and system interlock summaries are provided.

PLC LOGIC IMPLEMENTATION

The original design for the Ring HPRF controls at BNL was using Allen-Bradley PLC5/60 to connect to PC over a Data Highway Plus network, and drive Flex I/O and Block I/O over RIO

network. Because the SNS project has selected CLX as a standard PLC, a conversion from PLC-5 logic to CLX-based logic has been made. The communications among PLC, IOC and OPI hosts are via Ethernet network.

There are slight differences between the way a PLC5 processor implements block transfers (BT's) and the way a CLX implements block transfers. The main difference is the way the BT instruction is laid out and where the data is stored. The PLC5 uses BT Instructions and the data is stored in N-data files. The CLX uses MSG Instructions that can be configured for a Block Transfer Read it Block Transfer Write Message Type and the data is stored in INT Array Tags.

Remote/Local, ON/OFF/Standby, and Reset command are provided for the operators. The sequences are implemented in the PLC logic to control the cavities and monitor the interlock and status of equipment.

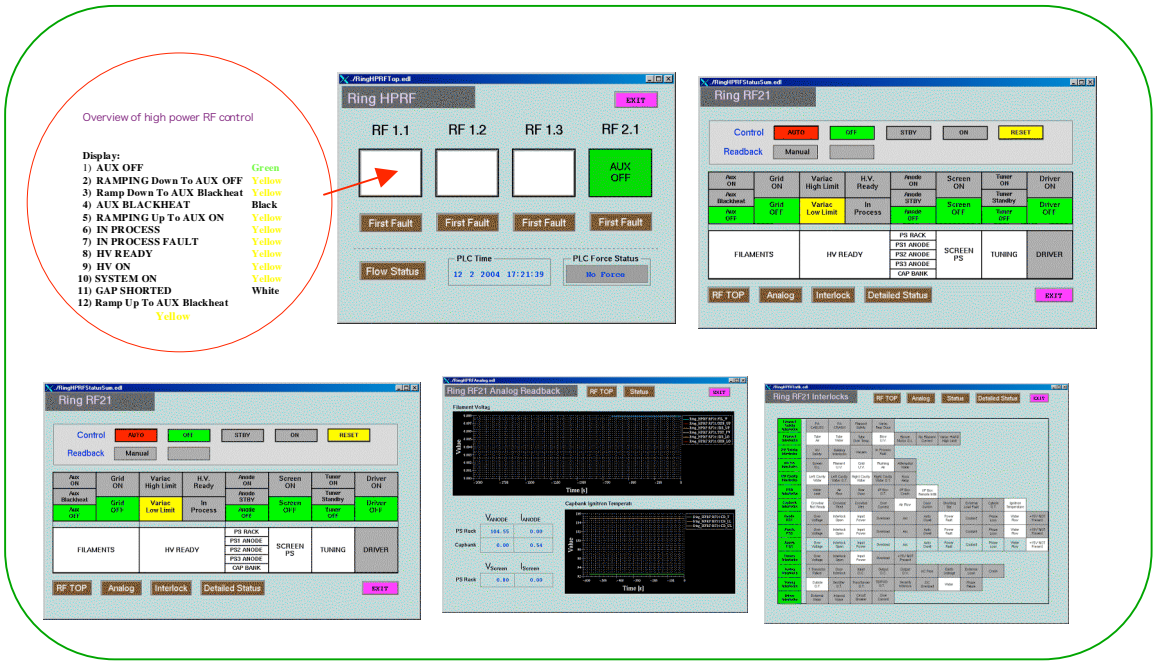

Figure 2: EDM Control Panels

SUMMARY

SNS Ring HPRF control system was designed, developed and tested at BNL. The installation of the system at SNS site is complete recently. The field test and further improvements such as more functionalities, better human interface with SNS standard colours, PLC communication and modules status and so on are in progress. The system will be commissioned in January 2006.

ACKNOWLEDGEMENT

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