A REMOTE PHASE LOCKING SYSTEM FOR THE RESONATORS OF LINAC AT IUAC

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Abstract

The first accelerating module, the Superbuncher (SB) and the Rebuncher (RB) of the superconducting linac of IUAC are currently operational[1]. The phase and amplitude locking of resonators, at the time of beam tuning and during occasional unlocking of the resonators during beam-time, used to be performed locally asking for more time and effort. As a part of automation, remote control of the phase/amplitude locking is developed and implemented on the first accelerating module. Compatibility to the existing Pelletron control system is maintained by using a compatible command interface on an embedded Ethernet linux server on the existing control network. The existing control client is used as it is on the front end. The system, operated from Pelletron/Linac control room, was used during the last linac beam acceleration for a duration of ~2 months. Saving of beam-time and ease of operation were observed apart from cost effectiveness of the system.

INTRODUCTION

The first module of the superconducting Linac Booster at IUAC consisting of eight superconducting resonators along with super-buncher and re-buncher is operational. The Linac control scheme[2] is used independently to make the resonator ready for phase locking and it takes care for beam acceleration through Linac with the help of the Pelletron control console. The local control station of the resonator incorporates a fast and the mechanical tuner (slow tuner) section. Slow tuner consists of Niobium bellows attached to the high voltage end of the resonator which can be moved by a few mm to tune the frequency. The slow tuner control electronics with the help of the flow control assembly keeps the average of the resonant frequency same as the master clock. A mass flow control for Helium gas is developed to incorporate the movement of the Niobium bellows [3]. The mass flow control consists of mechanical assembly having a proportional and solenoid valves connected to the bellows along with proper control electronics module to give necessary voltages to operate these valves. This is used to bring all the resonator frequencies close to the frequency of the master oscillator. The automation of the Linac control scheme is in progress for ease of operation without much human intervention. The manual control of the slow tuner electronics is modified for remote operation. The paper describes details of the hardware and software development of the same.

EXISTING SLOW TUNER CONTROL

The slow tuner control consists of a mechanical assembly for the flow of Helium gas along with a closed loop P-I controller for flow control [3]. The controller controls the flow of Helium gas inside the Niobium bellows by controlling the output voltage given to the proportional valve / solenoid valve enclosed inside a Helium vessel with proper transducer. The manifold is connected directly to the slow tuner bellows inside the cryostat which expands or contracts to change the frequency of the resonator.

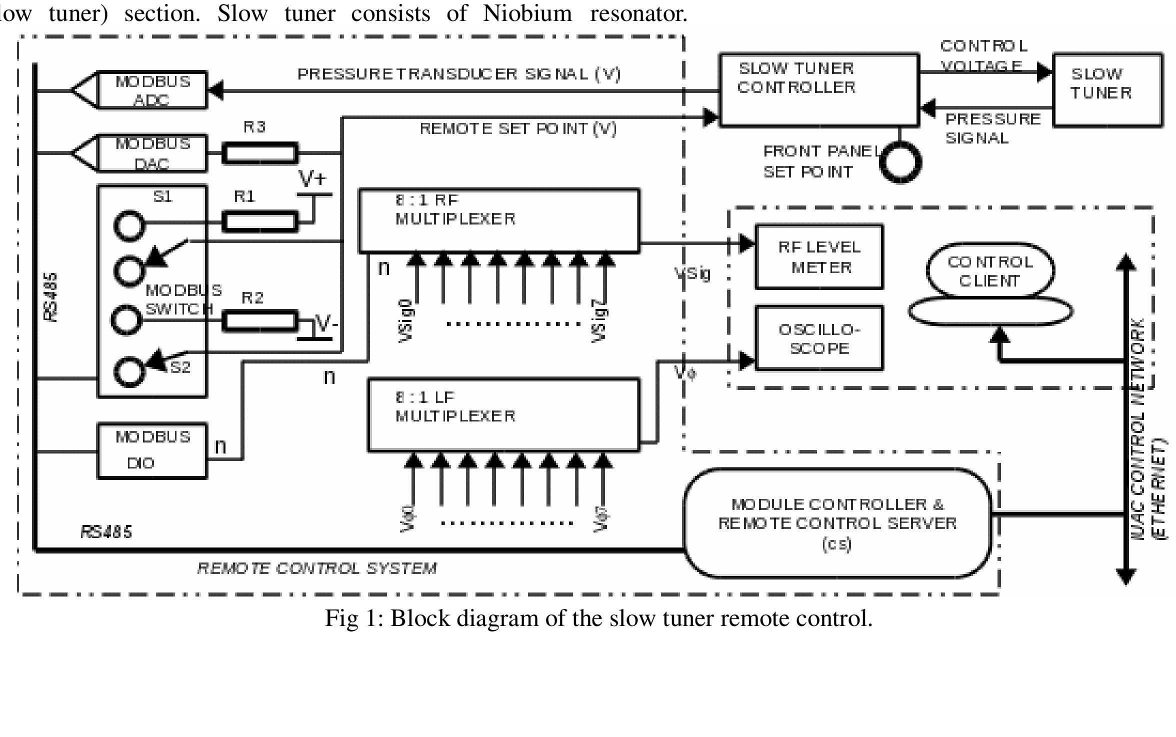

Fig 1: Block diagram of the slow tuner remote control.

The electronics control consists of a closed loop P-I control with the set-point provided manually using a voltage divider on the front panel. The control also has a provision to operate in both the saturated modes either fully vacuum or pressure using switch control. Once the reference is set the control senses the variation and maintains the stability. The set point is adjusted to bring the frequency close to reference master frequency during phase locking. The slow tuner control electronics module has eight such independent channels.

REMOTE CONTROL OF SLOW TUNER

The remote operation of the slow tuner electronics control is done by adding another set point to be operated from remote. This set point reference is provided by a remote controlled DAC. For saturated mode vacuum and pressure functions remote controlled switches are used in addition to the existing manual switches. For read back of the pressure signal a 16 bit ADC is used. Already RS485 MODBUS based remote controlled modules are used for design and implementation of a wireless control system for the ECR ion source [4]. Similar cost effective remote modules are used for this application. High resolution ADCs and DACs are used to provide set point and readback with high accuracy. All the eight channels of the slow-tuner control electronics are interfaced. The RF and low frequency multiplexing of eight channels is also interfaced for monitoring of the pickup and phase/ amplitude error using these modules.

OPERATION AND IMPLEMENTATION

The slow tuner remote control system for a single channel is shown in Fig 1. A MODBUS DAC and a MODBUS switch module with switches S1 and S2 along with resistors R1, R2 and R3 provide the set-point and the provision to operate in the saturated modes of vacuum or pressure. The DAC voltage provides the set point adjusted from the control room. For saturated mode operation, either S1 or S2 is operated from the control room. The operations of switches and DACs are done as per the commands sent by the client in control room to the controller connected with a linux server. The 97 MHz cavity pickup signals, Vsig0-Vsig7, are multiplexed using an RF multiplexer and only one RF cable carries the Vsig for the selected cavity to the control room. A MODBUS digital Input / Output (DIO) module provides a 3 bit number n for Channel selection of the RF multiplexer.The phase error signal, V⤧0- V⤧7, are monitored from the control room by an analog multiplexer. This is implemented using gold plated read switches and decoder logic on a PCB. 16 bit ADC module (fig 1) is used to monitor the pressure transducer signal from the control room.

The controller / server (CS) is an embedded computer with ethernet and RS485 interface to connect to the control network and the MODBUS modules. This system is assigned a unique IP address. Each module of the RS485 MODBUS is assigned a unique RS485 address.

SOFTWARE

The control / server program runs on the controller / server. Each individual DAC channel, switch and ADC channel is identified by a unique label name according the label naming requirements of the control protocol. Label names and attributes are listed in the server database file. MODBUS address mapping is done according to the label names to identify different channels. Multiplexer selection is done by the server and control program according to selected channel. The client side page files are created according to the label names scheme of the parameters. Fig 2 shows a simplified schematic of the layered software structure of the system.

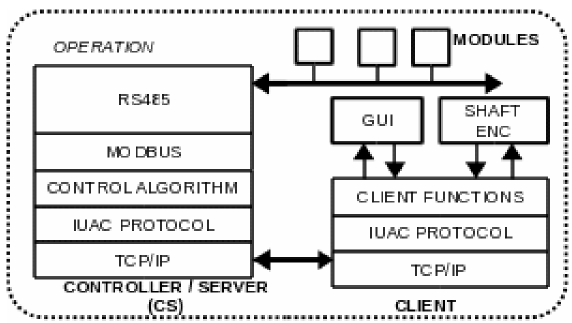

Fig 2: Software Architecture of the system

CONCLUSION

The remote control scheme for phase locking of the resonators was operated from Pelletron / Linac control room during the last beam time for a duration of ~2 months and proved to be a step forward for automation of the control scheme. This is also planned for implementation in the future control scheme.

REFERENCES

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