DESIGN AND IMPLEMENTATION OF A WIRELESS CONTROL SYSTEM FOR THE 18 GHZ HIGH TEMPERATURE SUPERCONDUCTING ECR ION SOURCE, PKDELIS

R.N.Dutt, G.Rodrigues, Y.Mathur, U.K.Rao, A.Mandal & D.Kanjilal
Inter-University Accelerater Centre, Aruna Asaf Ali Marg, New Delhi 110067, INDIA

Abstract

A wireless control system has been designed based on MODBUS protocol and implemented for the control and operation of the 18GHz High Temperature Superconducting ECR Ion Source (HTS-ECRIS) PKDELIS on a 40kV/100 kV high voltage platform and the Low Energy Beam Transport Section. This system makes operation and control of the devices on the 40kV/100 kV high voltage platforms easy and is found to be robust in spark environments. For interlocking purposes with fail-safe operation at the hardware level, commercially available PLC's are used. The performance to cost ratio has been maximised when compared to Field Point modules. The system has been in continuous operation for more than three years. The design and performance of this system will be presented in detail.

INTRODUCTION

The High Temperature Superconducting ECR ion source, PKDELIS [1], operating at 18 GHz is designed to inject beams from the High Current Injector into the existing superconducting linear accelerator. The ECRIS is driven by an 18 GHz, 1.8 kW Klystron for sustaining the plasma. The source has been recently upgraded with an additional variable frequency functionality by incorporating a TWT amplifier and variable frequency function generator. The low energy beam transport section consists of the HTS PKDELIS ECR ion source, beam extraction system and a mass analyzer followed by a diagnostic system consisting of double slits, beam profile monitors and Faraday cups.

The centralized control system at IUAC is an ethernet TCP/IP based control scheme. A high level protocol on TCP/IP for data transfer / control is used in this system. The central control room houses the main control clients to be used by the operators. This client uses the TCP/IP protocol for communication with the server. The wireless control system for the HTS ECRIS- LEBT has been developed to provide both local operation and the ethernet TCP/IP based remote control. Distributed control topology has been adopted from the main control room. In the local control console of the source, functionality is enhanced by addition of graphs/charts and data logging functions. For interlocking, PLCs have been used. Automation work has been started.

The control scheme of the PKDELIS HTS ECR ion source [2] for the High Current Injector has been implemented using radio modems. The local and remote control features have been functional for more than three years.

DESCRIPTION

Isolation Channel

Electrically isolated control channels for ion sources are commonly fibre optic links. However a radio channel can maximize reliability and minimize system downtime for round the clock operation due to the total absence of any mechanical contacts and sparks.

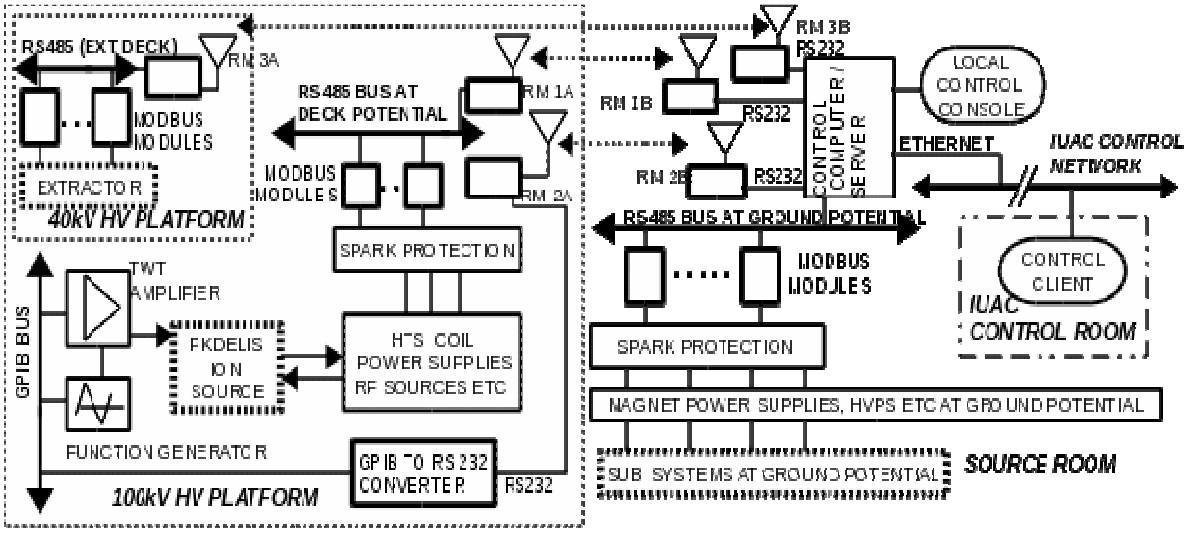

Figure 1: Block diagram of the wireless based control system for the PKDELIS ion source and LEBT

Commercially available ISM band 2.45 GHz radio modems using CDMA encoding for data have high data integrity and reliability. Radio modems can be easily interfaced to the system at the hardware level and provide easy data access.

Local Bus

For control / monitoring of devices on HV platform, Fieldbus approach has been adopted. An RS485 based MODBUS/RTU system is incorporated as the local Fieldbus using a twisted pair backplane. The RS 485 network is spread across the isolation channel (Radio Modems). The MODBUS devices appear as RS485 devices connected directly to the controller at ground potential. This makes information available to the local control console / server in real time. This also makes automation processes like fast beam scan possible.

Interlocks

PLCs provide the most reliable way of hardware interlocks in the event of a software failure. This also provides a method of monitoring the interlock status. MODBUS PLCs are employed for compatibility. They provide connectivity to the control system using standard protocols.

Implementation

The control system implementation is shown in Fig 1. Radio modem pairs RM1A-RM1B, RM2A-RM2B and RM3A-RM3B provide the isolated channels. The RM1A-RM1B and RM2A-RM2B links facilitate control and data access for HV platforms. All the subsystems on the deck are connected to this control channel. The GPIB based TWT amplifier and the function generator have been connected via the RM3A-RM3B channel. This channel connects to the GPIB bus via the RS232 to GPIB converter as shown in the figure. The systems at ground potential, mainly the diagnostics and analyzer systems are also connected to the controller.

SOFTWARE

Programs are developed for local and remote operation of the source. The local control program uses standard MODBUS libraries for accessing modules.

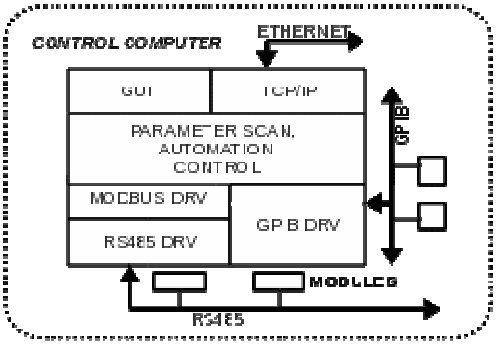

Figure 2: Simplified block diagram of software.

The local programs have the regular parameter scan and control operations for control of the source. The MODBUS devices on the busses are accessed at regular interval. Scaling and linearization of every parameter is done individually to display the value of the parameter. Parameters are displayed on GUI based digital indicators, analog meters and gauges on the front panel. Some parameters are displayed as a parameter vs time chart. Control is via GUI based digital control objects and GUI based analog control knobs. An automatic scan routine facilitates automatic scanning of a M/q spectrum. The automatic and parameter scan control operations in the local mode are based on Labview from National Instruments. Fig 2 shows a simplified block diagram of the software. Figure 3 shows a typical scan for acquiring a charge state distribution of a particular source tune.

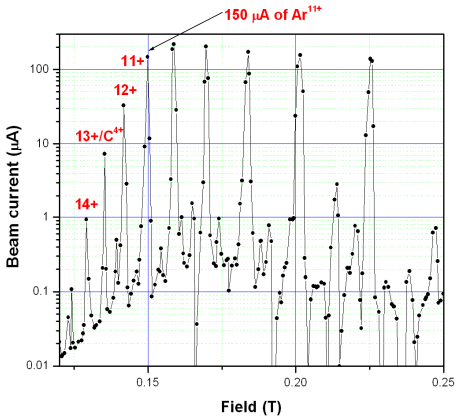

Figure 3**.** A typical scan for acquiring a charge state distribution

CONCLUSION

A wireless based control system for the HTS ECR ion source and LEBT has been successfully implemented. The system has proven to be rugged, reliable, economical and robust even in spark environments.

REFERENCES

[1] D.Kanjilal, G.Rodrigues, P.Kumar, A.Mandal, A.Roy, C.Beith, S.Kantas, P.Sortais, Rev. Sci. Instrum. 77, (2006) 03A317

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