A WIRELESS CONTROL SYSTEM FOR THE HTS-ECRIS, PKDELIS AND LOW ENERGY BEAM TRANSPORT

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Abstract

The 18 GHz High Temperature Superconducting ECR ion source at the Inter University Accelerator Centre (IUAC), New Delhi is the first High Temperature ECR Ion source designed for operation on a 400 kV high voltage platform as part of the High Current Injector development programme. For automation of source operation and control of source parameters, a wireless control system has been developed. Connection to the Ethernet based central control system has been provided.

INTRODUCTION

The 18 GHz High Temperature Superconducting ECR ion source (ECRIS), PKDELIS[1, 2], is designed to inject multiply charged ion beams into the superconducting linear accelerator. The HTS-ECRIS is driven by an 18 GHz, 1.8 kW klystron and has been recently upgraded with an additional frequency by incorporating a TWT amplifier for alternate frequency injection and for double frequency operation [3]. The low energy beam transport section consists of the HTS -ECRIS, beam extraction system and a large acceptance mass analyser followed by a diagnostic system consisting of double slits, beam profile monitors and faraday cups [4]. The control system has been designed keeping standardization and reliability of the complete system. Module backplane, isolation channel, IO hardware and embedded hardware are industrial strength, fail-safe, reliable and widely supported. Speeds of module backplane, IO hardware and isolation channels are sufficient for feeding the control and automation requirements. Incorporation of spark protection and safety interlock systems are additional requirements for smooth operation of the complete system. Fieldbus technology offers several benefits in an ion source control application. An RS-485 MODBUS/RTU module backplane can be implemented using a single twisted pair and connect seamlessly to a wireless isolation channel, forming an industrial strength system. Simplicity of this bus helps ruggedness and easy maintenance. Multiple sourcing of industrial strength ADCs, DACs, DIO, relays and thermocouple modules is supported. Large amount of software development bus has been implemented as module backplane. This network, spread across the isolation channel (Radio Modems), appears as a local RS-485 MODBUS to the control computer on the ground. Such direct integration support for both Windows and LINUX systems is available. An RS-485 MODBUS/RTU twisted pair local of the isolation channel makes control parameters available in real time. The system has proven to be simple, rugged, robust economical and reliable. Common electrical isolation channels in ion sources are fibre optic links. However, a radio channel can maximize reliability and minimize downtime due to total absence of any mechanical contacts and make source operation easy and convenient. Commercially available ISM band 2.45 GHz CDMA radio modems have high data integrity and reliability. The TWT amplifier and associated function generator provide only GPIB channel for control. These systems are connected using a GPIB to RS-232 conversion and connection via a Radio Modem. An additional software module for interfacing to the GPIB functions via the converter is then required. The central control system of IUAC runs a high level protocol using an Ethernet TCP/IP based central control scheme. A distributed control topology is used to enable control from the control room of IUAC. Several enhanced control functions are available in the local mode. Local control also supports enhanced graphics and GUI based control functionality. The system has been running for more than five years with reliable operation.

DESCRIPTION

A block diagram of the system architecture is shown in Figure 1. Radio modem links RM1a-RM1b and RM2a-RM2b provide the basic isolation channels for systems of the source on a 400 kV high voltage platform. The RM1a-RM1b link provides control of all the parameters. The RM2a-RM2b link is for the GPIB based second link for the TWT amplifier and the function generator associated with it. The ground potential systems have more flexibility due lack of the limitation of the isolation channel. A non-isolated RS485 MODBUS serves this purpose. The MODBUS parameter scan program scans the bus for all the parameters at a regular interval. The scaling and linearization is done individually and the parameters are displayed graphically as well on GUI objects.

Interlocks are provided via PLCs as they provide the most modern and reliable mode of interlock. They can also be connected to the control system to provide the interlock status. They also provide connectivity using standard protocols.

SOFTWARE SYSTEM

A simplified block diagram of the software is shown in Figure 2. The program uses GUI for display of control and read-back parameters. Graphical plots provide histories of vital parameters like gas pressure, vacuum levels at various positions in the beam-line, drain currents from power supplies etc. Addition of auto-scan and interlock features has been implemented. To support Ethernet based control protocol, a service interface has

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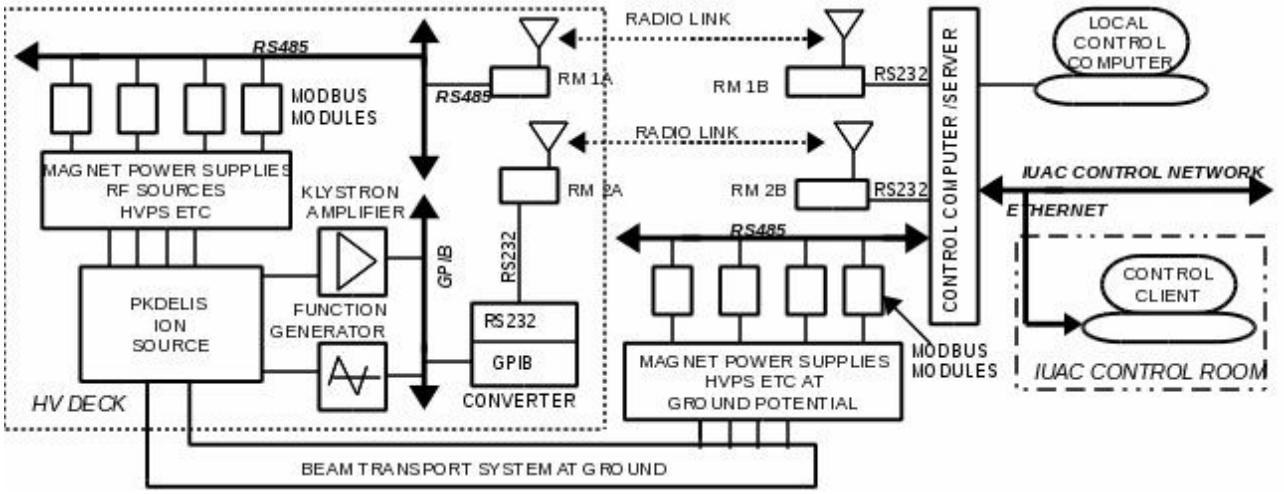

Figure 1: Schematic of the wireless based control system.

been implemented on Ethernet for connection to main control after parsing are passed on to the front end for IO access. Parameters are looked up from database file containing local MODBUS addresses and parameter scaling information.

INTERLOCKS

Interlocks are provided for high voltage power supplies, magnet power supplies, RF amplifier, vacuum pumps and other sensitive systems. To maximize reliability, a PLC system has been incorporated with interlocks set at the hardware level.

SERVICE, MAINTENANCE AND UPGRADATION

All the control hardware including the control modules, the isolation channel, the server hardware, the control hardware and other systems are devised as industry standard systems. A standard RS-485 has been used as the standard backplane and MODBUS as a standard protocol sourcing of control hardware is standardized. The Ethernet server and hardware are built using standard Intel based fan-less systems. A strong support exists for MODBUS libraries for all the platforms including UNIX, LINUX, Windows(TM) and LabVIEW (TM).

CONCLUSION

The wireless based control system for the HTS-ECRIS and low energy beam transport has proven to be a reliable workhorse in terms of smooth operation [5] inspite of the severe spark environment. Interference due to sparks during the communication and control of various parameters has not been observed, since the spark frequency spectrum is way below the control frequency of 2.45 GHz.

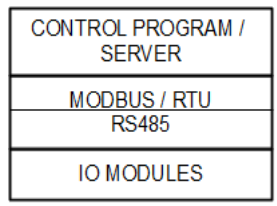

Figure 2: Control program and interface.

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