MODIFICATIONS AND INPROVEMENTS IN THE REMOTE CONTROL SYSTEM OF THE HIGH CURRENT ION SOURCE

Mou Chatterjee, Dhananjoy Koley, P.Y. Nabhiraj, V.S. Pandit
Variable Energy Cyclotron Centre, 1-AF Bidhannagar, Kolkata – 700 064

Abstract:

A PC based remote control and monitoring system for indigenously developed 2.45GHz high current microwave ion source has been discussed. The system architecture is made modular with dedicated control nodes for individual sub systems. The PC based supervisory console is connected with the control nodes in RS485 multi-drop fashion through an indigenously developed optical fibre based serial link for electrical isolation. A protection circuit has been implemented to reduce the interference in the circuit caused due to sparks in the high voltage deck.

INTRODUCTION

The indigenously developed 2.45GHz microwave high current ion source, to produce 100keV proton beam for injection into a 10 MeV compact cyclotron has been commissioned and is presently under testing for performance improvement. The system consists of various sub-systems e.g. microwave generator, microwave tuner, solenoid magnet power supplies and gas feeding system. Initially a PC based centralised control system, using NIFP modules, was implemented for the system. Due to its complicacy of trouble shooting and difficulty of dismantling during mechanical maintenance, the system is replaced with a distributed modular architecture.

Since all subsystems of the ion source are placed on the high voltage deck, an isolated, reliable control system is required for remote monitoring and operation. Present control system uses Advantech ADAM modules. The system architecture is made modular with dedicated control nodes for individual sub system. The PC based supervisory console is connected with the control nodes in RS485 multi-drop fashion through an indigenously developed optical fibre based serial link for electrical isolation.

As the control system is installed on a 100kV high voltage deck, frequent sparks used to cause communication failure and sometimes damage to the components of the control system. A protection circuit is implemented to reduce these effects. A remote monitoring system, using National Instruments Field Point (NIFP) modules, has been developed to monitor the Faraday Cup and Slit currents. The similar protection circuit is also used in this system to reduce the damage.

CONTROL SYSTEM

Control Hardware

In the distributed modular control architecture (as shown in Fig.1), dedicated monitoring and control nodes are developed for individual sub system. Advantech ADAM modules, supporting RS-485 protocol, are used for control and monitoring both analog and digital parameters in the control nodes. All control nodes are connected with a multi-dropped RS-485 network for communication with the supervisory system. Since the control nodes are placed on the 100kV deck, electrical isolation is to be provided between the control system and supervisory system for operational and instrumentation safety. The isolation is provided by an indigenously developed optical fibre based serial link. Agilent make HFBR 1521 and HFBR 2521, used as the optical transmitter and receiver respectively, with a pair of plastic optical fiber of 1mm diameter are used to make the isolator unit. This optical fiber supports maximum 5Mbps data rate upto 30m distance.

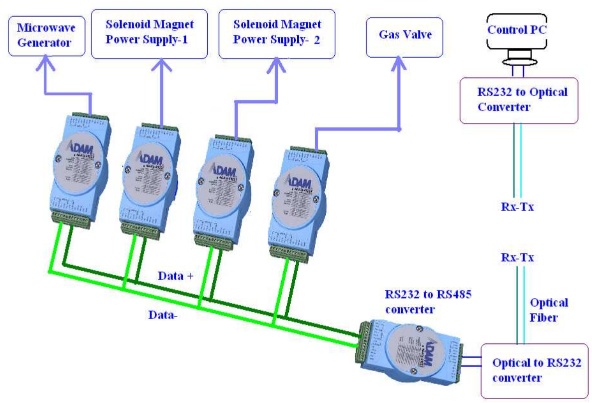

Figure 1: Block Schematic of the control system

Protection circuit

To reduce damage of the control hardware and communication failure due to frequent high voltage sparks during testing of the system, a protection system is developed and implemented. The protection circuit has two layers. The first layer is a transient voltage suppressor that limits the input voltage by shunting the spark energy to ground potential. The second layer is a passive low pass filter that blocks the high frequency energy of the spark. The sensitive instrument and control hardware are protected by shunting the high energy during sparks through the protection system.

Supervisory Control software

The supervisory control software, developed in house using NI LabView 7.1, is composed of user interfaces for individual subsystem. Several operational safety interlocks are implemented in this software e.g. (i) automatic resetting of solenoid power supply current set point to zero value on power supply trip; (ii) withdrawal of microwave power on solenoid power supply trip and preventing microwave power to be set until sufficient solenoid current is already given. The supervisory software user interface as shown in Fig.2, also incorporates user friendly indication and control interface e.g. sliding bar, push button, LED indication, digital display etc for ease of operation of the system.

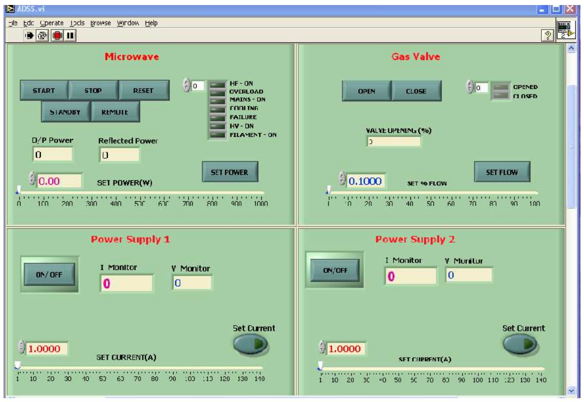

Fig 2: Graphical user interface developed in LabVIEW.

Faraday Cup and slit current monitoring system

A PC based monitoring system the schematic of which is shown in Fig.3, is developed for the measurement of faraday cup and slit jaw currents using NIFP modules. The input current signals are fed to the analog channel through the spark protection circuit. The supervisory software, developed using NI LabView 7.1, acquires data from the monitoring hardware through RS-232 interface. The user interface includes real-time trending of current data against time and logging of time stamped data in MS Excel file for offline analysis.

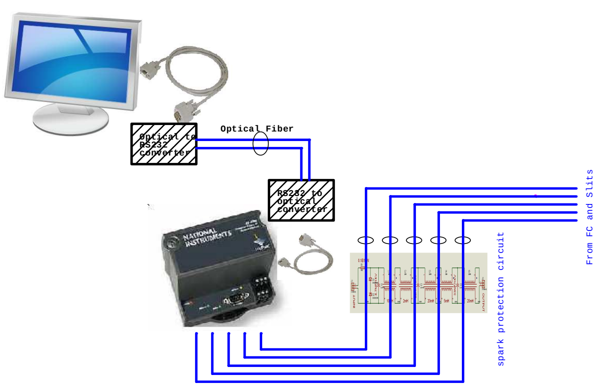

Figure 3: Faraday cup and slit current monitoring system.

CONCLUSION

The modular control system made mechanical maintenance and dismantling much easier. As one individual unit is dedicated for each subsystem, troubleshooting of the control hardware became easier.

The difficulties observed with the earlier control system were mainly the damage of components due to high voltage sparks. The spark protection circuit has taken care of this very well and the system is working reliably.

The logged data for the faraday cup and slit currents is used for further derivations and checking reliability of the system.

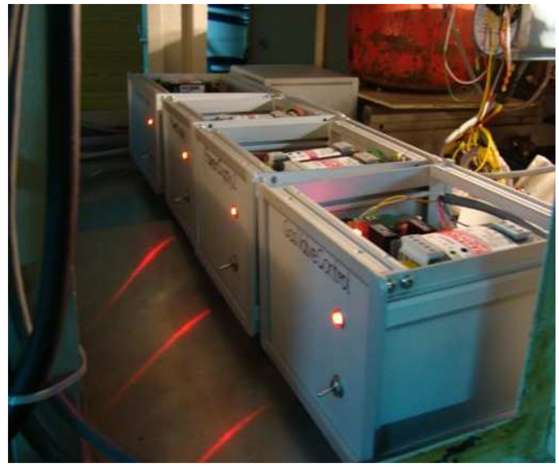

Figure 4: Control system assembly of the ion source.

REFERENCES

[1] Mou Chatterjee et.al. “An Isolated Remote Control System for the High Current Ion Source”InPAC-2009, Indore.

[2] Kelly S. Robinson, John J. Coleman, “Spark Protection Circuit for measuring current in high-voltage circuits.” Journal of Electrostatics, vol. 63 (2005) 285.