ELECTRON CYCLOTRON RESONANCE ION SOURCE CONTROL SYSTEM

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Abstract

The ECR Ion source control system is a computer based control system. Main components of the ECR ion source are microwave generation, plasma chamber, solenoid magnets and power supplies, extraction electrodes and power supplies, beam measuring device and vacuum system (see Figure 1). All electronics devices have their built in microprocessor base electronic interface, which can be remotely accessed by serial or Ethernet link. Two Ethernet to four port serial converter are used to extend the serial port of the computer. Serial interface of all the devices are connected to the extended serial ports of the computer. A serial link of high voltage power supplies have provided optical isolation using serial to optical converter to overcome EMI and EMC problems. The software has been developed in house for remote operation of the ECR ion source.

INTRODUCTION

An ECR proton ion source has been developed for the Low Energy High Intensity Proton Accelerator (LEHIPA) [1]. The ion beam current of 42 mA (unanalyzed) has been extracted at 40 keV of beam energy. The three electrode extraction geometry has been used for ion extraction. For reliable, stable and longtime operations of the ion source it is mandatory to monitor forward and reflected microwave power, gas pressure, magnetic field and the beam parameters. The ECR ion source is sub divided in to microwave section, solenoid coil and its power supplies, high voltage power supplies, vacuum system and beam measuring device (Faraday cup). Remote operation of all section has been done using computer. Detailed control system is discussed in control system design.

CONTROL SYSTEM ARCHITECTURE

The control system of ECR ion source is computer based control system. Control system architecture is shown in Figure 2. Industrial Ethernet switch MOXA EDS208 [2] is connected to the computer. Two MOXA 5450I ethernet to 4 port serial converter is used to extend the serial port of the computer via Ethernet switch. All the five sections of ECR ion source are

Microwave Section

A 0-2 kilowatt microwave generator (magnetron) is used to feed microwave power to the plasma chamber. Microwave generator is remotely accessed via a serial RS232 link. For monitoring of the microwave power a dual channel RF power meter is used which is also remotely accessed via serial RS232 link. Both microwave generator and RF power meter assigned their dedicated serial port which is shown in Fig. 2.

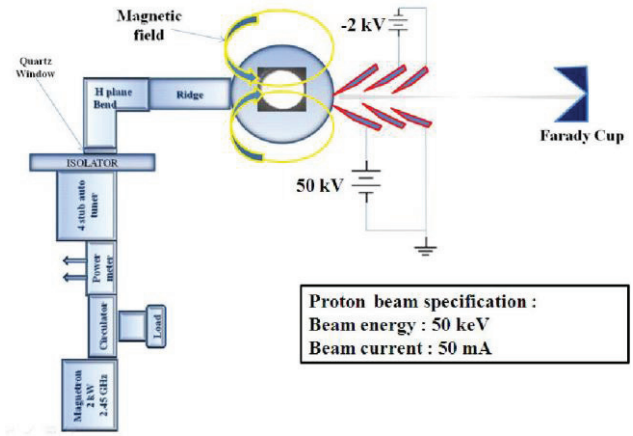

Figure 1 : ECR ion source.

Solenoid Magnet Power Supplies

For generating electron cyclotron resonance condition two solenoid coils are used to produce axial magnetic field of 832 Gauss on plasma chamber. High current power supplies of 800A, 10 V are used to supply high current in solenoid coils. Both high current power supplies are remotely accessed and have their dedicated comport.

High Voltage Power Supplies

Two high voltage power supplies rated 50 kV, 100 mA and -2kV, 100 mA are used for ion beam extraction. Both high voltage power supplies have given input power via isolation transformer to overcome ground loop problem. High voltage power supplies have remoter operation feature of 0-5 V analog input voltage type. Like 0-5 V analog input correspond to 0 – 50kV or 0 – (-2kV) V_{out}. Remote operation of HVPS is done using RS485 serial interface. Serial to optical conversion using MOXA TCF 142 has been done to provide isolation of HVPS and automation computer. An ADAM 4017+ [3] is used to provide analog output 0-5 V to HVPS. For voltage read back of 0-5V ADAM 4024 analog input module is used. Switching between remote and local mode is done using an ADAM 4068 relay module. All these ADAM modules are controlled from a single RS485 serial interface link.

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ISBN 978-3-95450-124-3

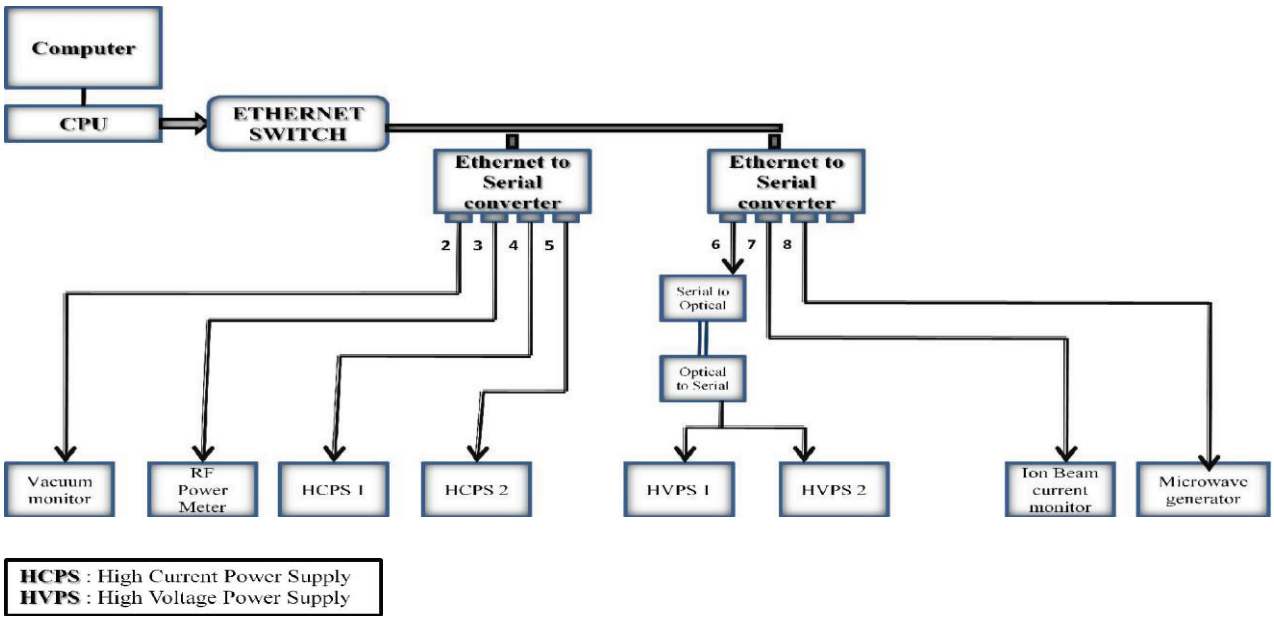

Figure.2: Control system architecture

Beam Current and Vacuum Monitor

The faraday cup is used for continues ion beam current measurement. A current shunt of 100 ohms is used and the voltage across it is measured using an ADAM 4024 analog input module. Vacuum gauges are used to monitor vacuum level and are connected to a vacuum gauge controller. A vacuum gauge controller is remotely accessed via a serial RS232 link.

Control System Software

The ECR control system is a computer based control system. Graphic user interface can be developed in any platform like QT, JAVA.

Conclusion

The ECR ion source control system up to the proton beam extraction has been designed and developed. Future part of the system is the development of the control system for the ECR ion source beam line.

ACKNOWLEDGMENT

The author wishes to thank Dr. L.M. Gantayat, Director, BTDG, BARC for his keen interest and support for this work. The author also wishes to thank Shri R.B. Chavan (SO/C, APPD) and Shri Sudhir Singh (SO/F, IADD) for their guidance during the work.

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ISBN 978-3-95450-124-3