# UPDATION OF ECR POWER SUPPLY CONTROLS TO DISTRIBUTED PC ENVIRONMENT

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*Abstract*

Controls of the ECR source and the beam-handling elements for injection of the heavy ions into the cyclotron, are being shifted to the central control room, in phases. The work constitutes a part of the retro-fitted distributed computerization of the Cyclotron. A Pentium, Win95 PC working in the ECR front-end takes care of the above power supplies controls. Existing CAMAC crate, several ADC & amp; DAC modules have been put to use, after in-house development of Windows compatible CAMAC library functions. VB callable hardware In/Out functions have been used in the libraries, by incorporating available freeware from internet. Several graphic bit-map icons, specially suited for the purpose, have been prepared and used in the VB MMI form. The Client-Server mode implementations of the distributed controls work using SocketWrench-VBX socket control on Windows-95.

## 1 INTRODUCTION

The Variable Energy Cyclotron (VEC) has recently been upgraded with Electron Cyclotron Resonance Ion Source (ECRIS) for increased scope of research. The ECRIS subsystem along with its manual control console is physically located on the high bay above the cyclotron vault. The separate control console located at a great distance from the cyclotron control console is logistically inconvenient from the control perspective as well as deployment of man power. Therefore, to partly reduce this inconvenience computerized control has been planned for ECRIS operation. It was decided that one of the computerized consoles of ECRIS would be located in the cyclotron control room as a remote console. This has generated the work on the computerization of the ECRIS parameters and remotely operable control software.

In this paper we describe various schemes we have explored for control of the ECRIS power supplies from PC with the help of the existing and easily procurable hardware. Since none of the power supply (except two numbers) has any computer interface our tasks are to develop, appropriate hardware to make the power supply suitable for remote SET and MONITOR operations, the computer interfaces and the I/O libraries for the interfaces.

## 2 HARDWARE ASPECTS

There are altogether 32 power supplies in the ECRIS subsystem including injection line, puller and bias supply and the ion-source itself. At present it is planned to computerize only the injection line power supplies which are 22 in numbers with ratings from 0-1A 0-30 V DC to 0-350A 0-20V DC and tolerances from 0.01% to 0.05%. All these power supplies are operating in current controlled mode and are electrically floating and isolated. None of these power supplies has any form of computer interface.

In this project, as far as the hardware aspects are concerned we have basically explored two schemes to control the power supplies: in one, the DAC-ADCs were kept outside the power supply and in the other, the converters were integrated within the power supply cabinet.

### *2.1 SCHEME 1*

We started the computerization with a 0-1A 30 V DC power supply which was fortunately available as spare at that point of time. The control circuit was studied and suitable amplifier circuit using low cost OpAmps was designed to replace the potentiometer reference control with DAC controllable reference and the monitoring point was also properly buffered. The schematic diagram is shown in Figure 1.

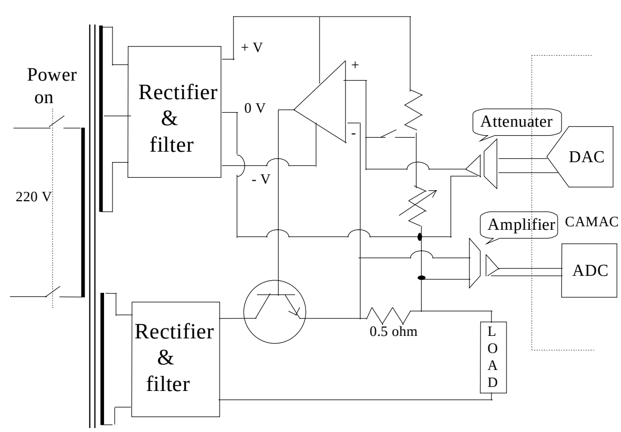


Figure 1: Schematic of control circuit connection.

The power supply was controlled by a 12-bit DAC and monitored by a relay multiplexer followed by 12-bit ADC

CAMAC modules. The CAMAC system was organised in serial configuration. The control PC was connected to a PARALLEL BUS crate controller and situated close to the PC. The remote crate located at an electrical distance of 250 meters was accessed through a Serial Highway Driver module in the local crate and an L2 crate controller at the remote crate. The DAC, ADC, and relay multiplexer CAMAC modules were put in the remote crate. The power supply reference and monitoring point was connected to DAC O/P and relay multiplexer I/P by 10 meters of twisted shielded cables. Figure 2 shows the hardware architecture of the control system.

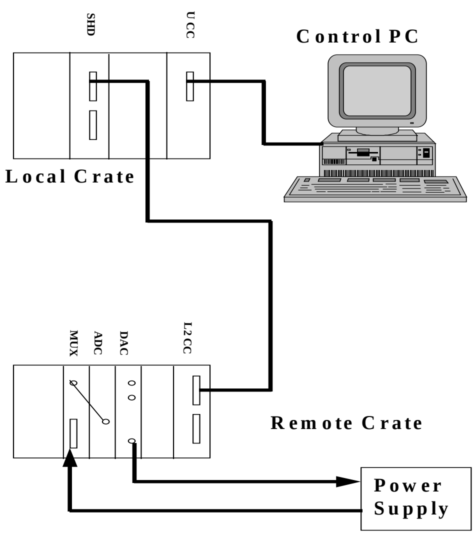


Figure 2: Schematic of Hardware architecture

The distribution of the measured O/P values indicated a FWHM of 0.085 % of full scale. The distribution of the measured O/P is shown in Figure 3. This result shows that we can even use a remote DAC and ADC if the 0.1 % is acceptable.

In this experiment the reference and monitoring points were however not isolated. At present we are developing an amplifier circuit with high quality isolation amplifiers and OpAmps.

## 2.2 SCHEME 2

As the above scheme is not suitable for a measurement accuracy, as well as stability, better than 0.1 %, we undertook the design of the coupling circuit using high precision DAC and ADC chips. In this design 16-bit DAC with stable reference, 16-bit ADC, isolation amplifiers and high stability OpAmps were integrated in a single board. This would be placed close to the analog control circuit of the power supply inside the power supply cabinet. The design of the circuit is complete and the circuit fabrication will start soon.

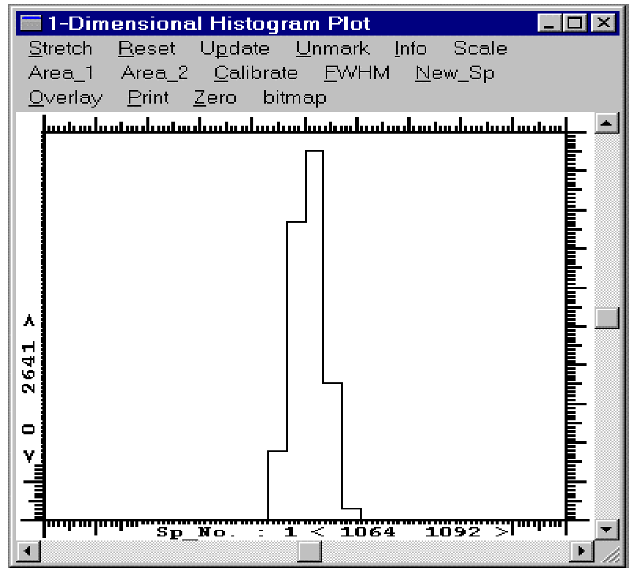


Figure 3: Histogram of the measured O/P voltage

In this configuration interfacing circuits are also required at the power supply and PC ends. At present we have designed and developed a parallel field bus system, as it could be easily built with low cost and available ICs. The total length involved is also within few meters. This system consists of a PC add-on I/O card, parallel bus driver and for each power supply a parallel bus interface. The parallel bus driver initiates a bus transaction when a command (READ / WRITE) is written on it through the PC add-on I/O card. We can connect a maximum of 64 power supplies in this method. The schematic is shown in Figure 4. The parallel bus circuit design and construction is in advanced stage of completion.

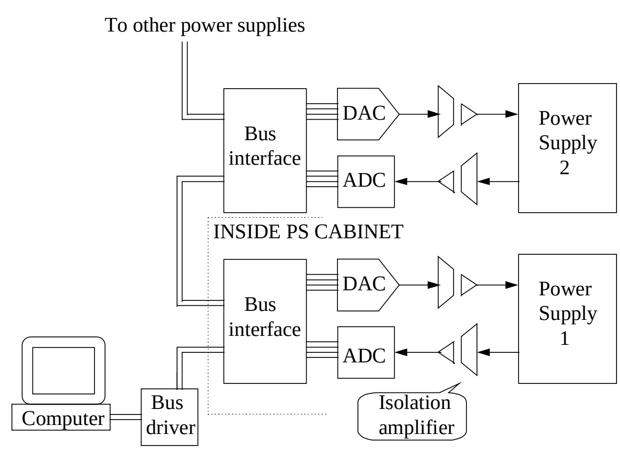


Figure 4: Converter connections in SCHEME 2

The parallel bus method, however, is being pursued as a temporary solution. It has been planned to replace this with a serial field bus. A prototype design with Intel 8251 microcontroller with RS 232 interface has been tested by connecting it to the COM port of PC. Work is now being initiated however, thinking of using a 16-bit microcontroller Intel 8796. The serial line protocol has not yet been finalised. Relative merits / demerits of a multidrop and star protocols are being studied. We may eventually decide in favour of a standard serial field bus e.g. CANBUS at a later stage.

## 3 SOFTWARE ASPECTS

The initial version of the control software with Human Computer Interface has already been developed by other colleagues [1]. In the present project we have developed the low-level functions for the hardware access from the control software. The necessary modification of the control software for remote or distributed operation are also being carried out.

### *3.1 LOW-LEVEL FUNCTIONS*

In the case of Scheme 1 we have developed the low level functions for CAMAC I/O using a downloaded freeware dynamic link library VBASM.DLL, as the basic port I/O functions are not available in VB 3.0. Each of the functions are basically sequence of port I/O operations to carry out the CAMAC module READ/WRITE in a serial CAMAC architecture. The DAC write function writes on the DAC input register of a particular DAC channel in the DAC module. The ADC read function first selects the desired channel of the relay multiplexer module, initiates conversion command in the ADC module and reads the converted data after the conversion is over. There are two more functions for setting and reading a specific bit in the CAMAC I/O register module. The last two functions are used for switching on the vacuum pumps and reading the interlock status and is not directly used for power supply control. All these functions are clubbed together in a VB module file and are called by the control software.

Similar I/O functions have been developed for the parallel I/O interface of the Scheme 2 and are about to be tested with the interface hardware on their completion.

Low level functions for the serial I/O have not been developed so far.

### *3.2 REMOTE/DISTRIBUTED OPERATION*

The control software is being modified for remote or distributed operations. The schematic of the distributed environment is depicted in the Figure 5. The control software residing on the PC on which the I/O hardware has been installed would act as server and also as client for local operation. In any other PC in the LAN e.g. PC in the cyclotron control room, the control software would act as client. The control software has been modified in such a way that the same software would auto-detect its role as server or client. If the client has proper authentication then it can do the same operation using the identical MMI as if the client is operating from the local PC. The client-server communication has been implemented using another downloaded freeware SocketWrench VBX socket control. The client-server version has already been tested. Now a protocol is being thought of, for co-operative access from multiple clients. The software is also being augmented with more dialog boxes and display windows for the power supply control and monitoring. This part of the work is being done in close collaboration with the other colleagues who have developed the initial version of the control software.

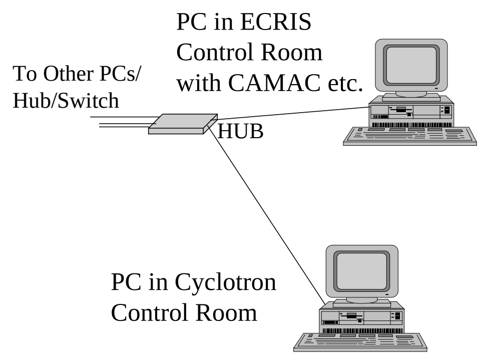


Figure 5: Distributed operation

## 4 CONCLUSIONS

The present project is one of the important parts of the computer control activity of this centre. The difficult area in this project is to make the power supply of different ratings and different manufacturer, computer controllable, mainly because the power supplies are already in the operational condition with the ECRIS system. The other parts are relatively straight forward and progressing at a reasonable pace. The experience to be gained in this project will be potentially useful in the Superconducting cyclotron control system.

## ACKNOWLEDGEMENT

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## REFERENCES

[1] Tapas Samanta, C. D. Datta and D. Sarkar, “Human Computer Interface for the Computerised Control of Electron-Cyclotron Resonance Ion Source (ECRIS) at Calcutta”, ICALEPCS’97, Nov. 3-7 1997.