

# A VERSATILE LOCAL CONTROL SYSTEM FOR THE LEIR/AD ELECTRON COOLER

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## Abstract

With the end of antiproton physics at LEAR in 1996, the electron cooling device was modified in order that it could be used for experiments with lead ions in 1997 in LEIR and then for installation in the AD machine the following year. As a consequence, as well as the mechanical modifications to the cooler, the control system also needed to be upgraded and it was decided to build a system that could run either from a PC or from a Workstation as used in the accelerator control rooms. This turned out to be the most efficient solution as no support was given for the maintenance of the old control system during the experiments with lead ions. The PC system was realised during the shutdown before the machine experiments started, leaving time during the rest of 1997 to build the VME interface for installation in the AD. In this paper the hardware and software implementations of this new control system are described and some ideas for the near future are also presented.

## 1 INTRODUCTION

The use of personal computers to interface hardware used in particle accelerators has become more popular in recent years due to the increased performance of PCs accompanied by a reduction in their price. It was therefore natural to adopt this solution to control the electron cooling device, which had undergone major modifications for tests with lead ions [1] in 1997 and for its future installation in the Antiproton Decelerator. Using our experience with PC based systems [2], hardware modifications were made to enable one to control the electron cooling device with a PC and also via the standard PS accelerator complex control system based on UNIX workstations and VME crates.

## 2 HARDWARE IMPLEMENTATION

### 2.1 General Layout

In order to reduce the cost and implementation time of the new control system, standard controls hardware and interfaces have been used. The power supplies, measurement systems and the safety chain are interfaced to the PC via standard 3 unit G64 systems controlled by a Motorola 6809 microprocessor with 64 Kbytes of memory and running at 4 MHz. Connection to the VME bus is made via a MIL1553 interface card for the control

and acquisition of the main power supplies (Figure 1). Control of the correction coils is done using a 32 channel 12 bit analogue I/O module and the safety chain is accessed via a 96 input digital I/O module (Figure 2). In addition some power supplies can also be controlled by function generators (GFA) which are needed to pulse the electron cooler when synchronous operation with the AD machine is required.

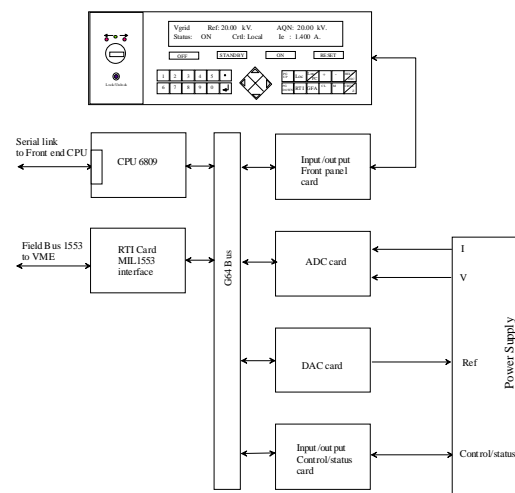


Figure 1: Layout for the control of a single power supply.

### 2.2 The Front-end Microprocessor

The front-end microprocessor, which is no more than another Motorola 6809, handles the interaction between the different access points (PC, VME and CAMAC are possible) and the elements of the electron cooler. The firmware programme is written in assembler language using an ICE Hewlett Packard development system and is burnt into an EPROM resident on the CPU board. Three main tasks compose the core of the operating system. A first task, which controls and acquires the power supplies, is activated every 100 ms. This program has priority over the two other tasks running in the CPU. A second task is activated only upon a VME (or CAMAC) request and a third task running in the background manages command or acquisition requests from the serial port connected to the PC. This serial link to the PC is in fact 12 de-multiplexed serial ports from the different microprocessor systems controlled by the front-end microprocessor (Figure 3).

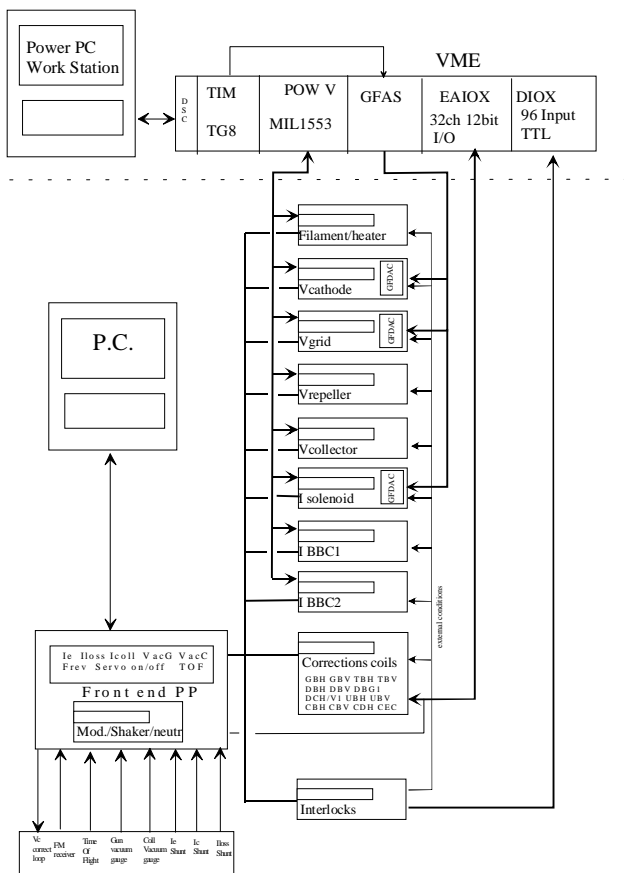


Figure 2: Schematic view of the control system.

### 3 SOFTWARE IMPLEMENTATION

The software implementation was performed in two stages. First of all, the PC utilities and applications programmes were written before the cooler was installed and operated in the LEIR machine. During the lead ion tests the development of the VME interface was initiated so that the final integration of the system could be done prior to the start-up of the AD commissioning.

The applications running on the PC were all developed using the software package TestPoint. This package supports acquisition from data acquisition boards, IEEE-488 instruments and RS232 devices, and combines this with analysis and display capability. TestPoint provides a contemporary, object-oriented graphic style of creating custom test, measurement and data acquisition applications. By dragging and dropping *objects*, which are icons representing related tasks, to an *action list*, it is easy to create applications without programming.

Professional looking applications are created by simply placing input, output, display, and control-button objects where you want them on the display window. During application development or test, a handy demo mode is available. This allows application development without the actual presence of hardware.

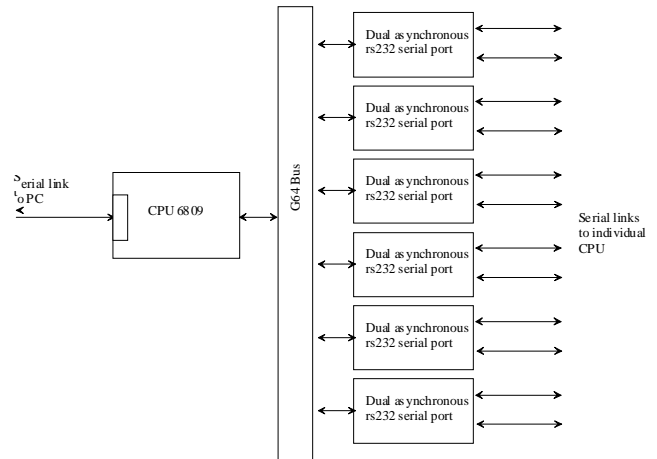


Figure 3: Front-end microprocessor layout.

TestPoint is an open architecture and environment. By adhering to the Microsoft Window environment standards, it supports direct data pipelining through Dynamic Data Exchange (DDE) to other popular Windows-based software packages (e.g. Excel and Word). It is also extendible via C, Visual Basic or other Windows languages through a Dynamic Link Library (DLL) interface allowing applications to also access any accelerator parameters via the “PC gateway” [3] available at CERN.

Before beginning to control the electron cooler a database storing the individual parameter settings (LSBs, min./max. values etc.) was created using an Excel spreadsheet. In this way the main application program can obtain updated information concerning any parameter of the electron cooler via a simple DDE access to the database.

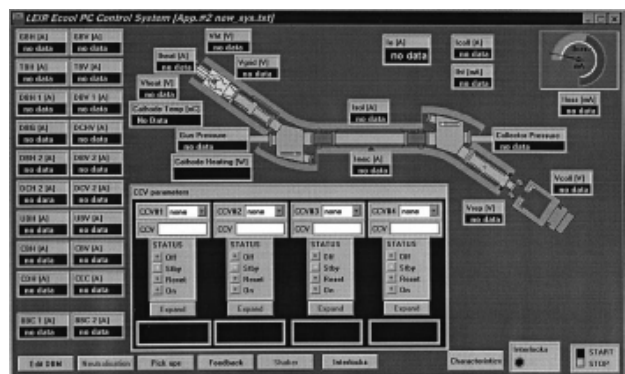


Figure 4: The PC interface to the electron cooling control system.

When initiated, the main application remotely opens the Excel database, downloads the relevant information and then starts an acquisition task. This task runs in the background and updates the buffer in which the acquisition (AQN) values are stored. Next the synoptic-like display of the electron cooler (Figure 4) is set up

and a second task is started, reading and converting the AQN buffer into real numbers and displaying them on the synoptic. To send a new control (CCV) value to any of the parameters, a panel containing a dropdown list of all the elements is visible below the synoptic. When a parameter is selected a window showing the current CCV value and status is opened and one can then either send a new CCV value or change the status of the element (Reset, Standby, On and Off). When this is performed, a special routine is run which momentarily suspends the acquisition task so that the serial link is available for sending data to the front-end processor. When this is terminated the acquisition task is restarted until the next control request.

More controls and special measurements, which are not available through the VME connection, can be accessed through a series of buttons situated at the bottom of the display. These consist of parameters such as the control of the neutralisation electrodes [4], the feedback system and the “shaker” [5]. These systems are not normally used during routine operation but are useful to have when performing machine studies or during the shutdown when a remote control system is required.

## 4 FUTURE DEVELOPMENTS

Since the first version of the electron cooler controls program, a number of new features have been added to the TestPoint package in the form of toolkits. Direct access to databases supporting the industry standard ODBC (Open DataBase Connectivity) drivers is now possible with the TestPoint Database Toolkit, and program control over the Internet using a web browser is also available with the Internet Toolkit. This opens up new possibilities for more efficient programming and also for remote control and diagnostics of the electron cooling device.

In a first stage the parameters database stored in the Excel spreadsheet has now been moved to a Microsoft Access DataBase. A second database containing the CCV and AQN values has also been created and is continuously updated by a dedicated application. The need to include parameter control and acquisition in any applications program has now been removed, with CCV and AQN values being set and acquired by a simple access to the database.

Using a web browser it will also be possible to make remote diagnostics of the electron cooling device. By running the TestPoint Web Server Program on the PC that is connected to the electron cooler, results and application panels can be viewed from any other PC via the Internet. Remote control of the device will also be made possible for the specialists through a small application that will transfer CCV data from the users' PC to the ecool PC and execute a control request.

## REFERENCES

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