

## Computer Control System for K150 Cyclotron

T. Cowden, F.P. Abegglen, R. Burch, and T. O'Berski

Since the most recent upgrade of the cyclotron computer control system, five years ago, the computer and semiconductor industry has rapidly changed. Almost all of the STD bus cards and the companies that made them have ceased to exist. Even the DIP chip is an endangered species. The extension of the computer control system to the twenty four power supplies of the K150 cyclotron would have to start from scratch.

The current system is based on using an STD bus crate to handle an average of eight power supplies a piece. Each crate has a processor card, a network card and various analog and digital I/O cards. The initial effort was to build on the existing STD bus interface, but simplify the I/O by shifting the burden to the power supply. With only a simple parallel TTL level or relay interface, no complex and unavailable analog STD cards would be needed. There was an added benefit of simpler digital electrical isolation, rather than the more complex analog isolation used previously. The standard interface for each new power supply was set at sixteen (16) bits read for the current, sixteen (16) bits written for the current control, six (6) relays to control the power supply and five (5) relay closures read as status bits.

Many systems were considered as replacements, but most fell short in the number of I/O points they could handle. It was stated that the ideal solution would be an inexpensive processor with Ethernet and enough I/O embedded in each power supply. It was speculated that such a product was still a few years down the road. In fact, subsequent searches found that such products already existed, and two different samples were purchased for test and evaluation. Both work with the existing control system on the communications level and have controlled a power supply under test. Both have C language development systems with multitasking extensions and example libraries. One system, the Rabbit 3200, is more suited than the other for the task at hand, but the second embedded processor is retained as a back up in an uncertain world.

Some of the advantages of the distributed embedded system were realized after the fact. The real time multitasking requirements of the system are reduced to one task per processor. The external wiring for the system is reduced to power and Cat5 Ethernet cable, all other wiring is short and inside the power supply. Each bank of supplies has an Ethernet hub/switch to further consolidate the wiring. Most of the adaptation of the hardware was to match the pinout of the processor to the wiring of the power supply. Only three semiconductors were added, a voltage regulator, a relay driver, and an LED indicator. The board the processor card attaches to is three inches by five inches (3"x5").

Nothing is without cost, however, as the total number of system messages goes up an order of magnitude. This can be countered with a differential message sending scheme, doing less frequent updates when the power supply values are static, more frequent while they change. The load handling ability of the higher levels of the control system do not seem to be taxed. The remaining unknown is long term reliability in a working cyclotron environment. The embedded systems seem robust, surviving the abuses of test and development well enough.