MASTER

A SMALL, MICROCOMPUTER-BASED CAMAC CONTROLLER

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The beam buncher necessary to condition the beam from the Oak Ridge National Laboratory (ORNL) 25 MV tandem accelerator for post-acceleration by the Oak Ridge Isochronous Cyclotron (ORIC) was designed at ORNL by N. F. Ziegler and W. T. Milner.[1,2] The buncher is CAMAC-based and will be controlled via one of the serial highways of the accelerator control system. However, prior to integration into the accelerator system, the buncher requires testing, including runs on the model EN tandem at Oak Ridge. In order to facilitate testing and initial operation of the buncher, a microcomputer-based controller was assembled.

The controller consists of a CAMAC crate, several CAMAC modules, a touch panel display, a controller box, and software. All of the CAMAC modules except one were purchased. The exception is a shaft encoder interface built into a single width CAMAC module.

The controller box contains one shaft encoder and two switches. One of the switches is a coarse/fine selector. The other switch is assignable via the touch panel display and is used, for example, to turn devices on and off.

The controller operates as follows: The names and values of all buncher parameters are presented simultaneously on the touch panel display screen. At the bottom of the screen are three labels. The leftmost label is a controllable parameter's name. Turning the shaft encoder knob adjusts the value of the named parameter. Touching the touch panel display at the displayed name causes another parameter's name to be displayed. Now this new parameter is adjustable via the shaft encoder knob. This is the assignment procedure for the shaft encoder.

The rightmost label at the bottom of the screen is the name of a discrete (i.e., on or off) parameter. Moving the assignable switch on the controller box upward sets the discrete value of the assigned parameter to a logical 1. In the case of a toggle function, releasing the momentary switch leaves the discrete output at a logical 1. In the case of a momentary function, releasing the switch resets the parameter to a logic 0. In the case of a toggle function, moving the assignable switch downward from the detent position resets the parameter. Assignment of another parameter to the assignable switch is accomplished by touching the screen at the position of the current parameter's name.

The center label at the bottom of the screen is a sequence number pertaining to shaft encoder assignments. It was felt that it would be inconvenient to have to cycle through a list of all possible shaft

encoder assignments if, for example, only two or three parameters are being iteratively tuned. Selecting sequence number one via a row of switches above the touch panel display selects a list of all possible shaft encoder assignments. Selecting other sequence numbers causes lists to be used for for assignments which are subsets of the complete list. The contents of particular sublists are determined by noting the various iterative procedures used to tune the buncher.

The CAMAC modules used in the controller, aside from the shaft encoder module mentioned before, are a Kinetic Systems (KS) 3880 micro-computer and an associated KS3909 auxiliary crate controller, a KS3992 serial highway driver, a KS3235 display and a KS5209 touch panel display. Any crate controller with an auxiliary bus interface may be placed in the crate's control station to provide the KS3909 access to the crate's N and L lines. The KS3880 module was modified to cause the clock interrupt to be latched and the KS3909 was modified to work with the CAMAC auxiliary bus.

The shaft encoder interface module contains interfaces for up to three shaft encoders. Each interface is essentially a 12 bit up/down counter with associated logic to prevent overflow or underflow, to extend the sign to 16 bits and to multiply the number of incoming pulses by four when the coarse switch is active. The interface is an incre-mental type; that is, a counter is cleared each time it is read so each reading represents the number of incoming pulses since the last reading.

The software is contained in erasable, programmable read-only memory (EPROM) in the KS3880. The program was assembled on the ORNL computer center's DEC-10 computer and downloaded into read-write memory (RAM) in the 3880 via a telephone link. When the program was deemed error-free it was set into EPROM.

The program consists of a high priority (foreground) task and a low priority (background) task. At 50 millisecond intervals the foreground task is started by a clock interrupt. The task reads the shaft encoder interface and updates the assigned parameter. Next, the assignable switch is read and appropriate action is taken on the assigned parameter. The sequence buttons and touch panel are queried for new assignments and, finally, all input parameters are read and a flag is set for each input that has changed since it was last read.

The background task uses whatever time is left in each 50 milli-second interval to scale and convert the flagged input parameters and to update the display.

Although the controller described is only temporary, it was thought to be useful to present it here. The controller can be quickly assembled to control any small CAMAC based system, the size constraint being the number of parameters that can be displayed on the display screen. The serial highway facilitates remote control, but in cases where remote control is not necessary, the serial highway may be eliminated to reduce cost. To further reduce costs, the touch panel display may also be eliminated and replaced with a simple video display and assignment buttons.

The controller was used for buncher tests on the EN tandem in September of this year.

References

1. Milner, W. T., IEEE Trans. Nucl. Sci. <u>NS-26</u>, No. 3 (Aug. 1979) 4399.
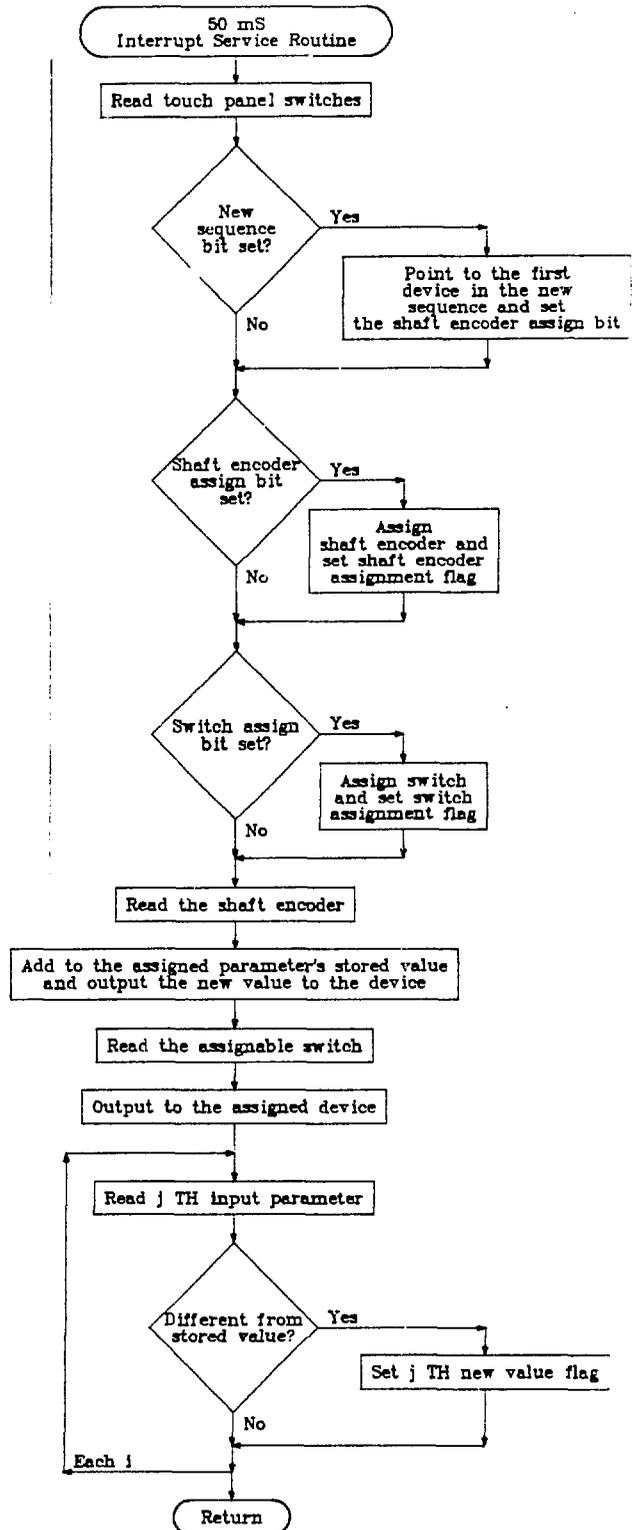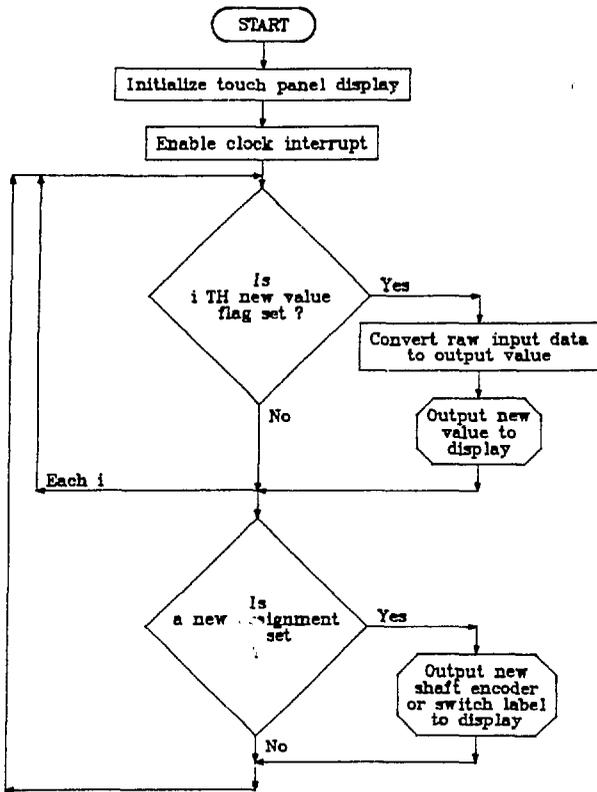
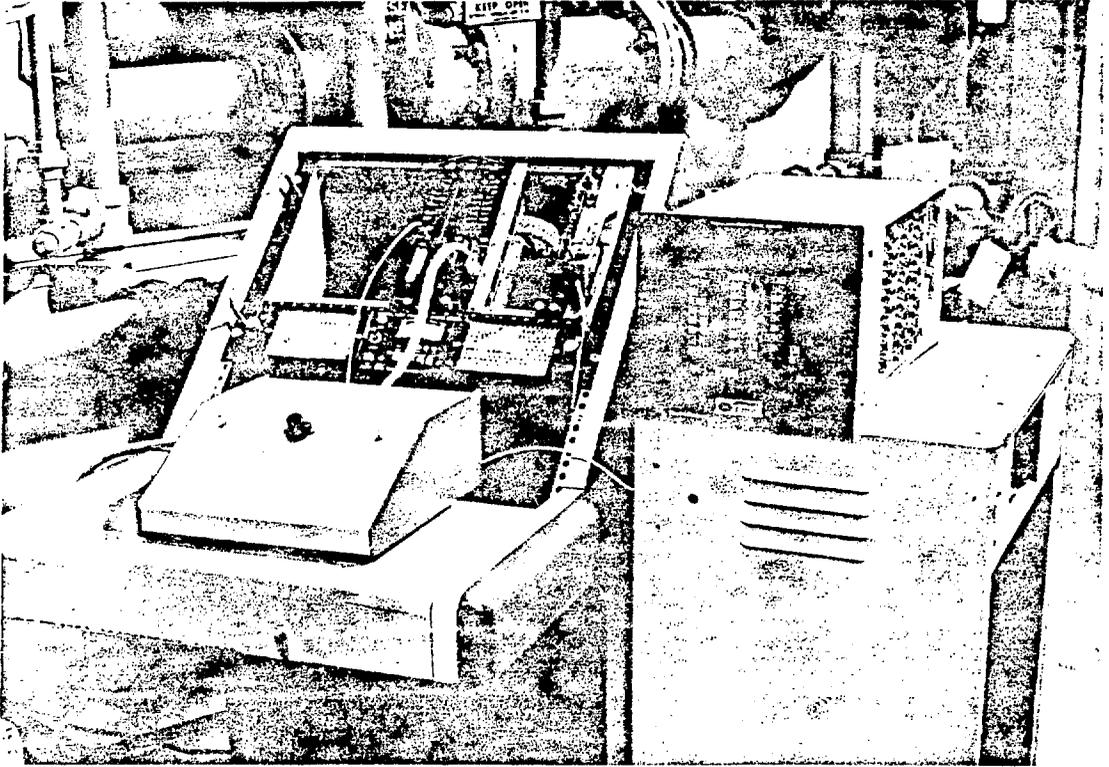2. Ziegler, N. F., ibid., p. 3304.

Fig. 1. Software Flow Diagram

Fig. 2.   CAMAC Controller