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A SINGLE-CRATE STAND-ALONE CAMAC CONTROL SYSTEM
FOR A NEGATIVE ION SOURCE TEST FACILITY

Raymond C. Juras and Norval F. Ziegler

MASTER

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Summary

A single-crate CAMAC system was configured to control a negative ion source development facility at ORNL and control software was written for the crate microcomputer. The software uses inputs from a touch panel and a shaft encoder to control the various operating parameters of the test facility and uses the touch panel to display the operating status. Communication to and from the equipment at ion source potential is accomplished over optical fibers from an ORNL-built CAMAC module. A receiver at ion source potential stores the transmitted data and some of these stored values are then used to control discrete parameters of the ion source (i.e., power supply on or off). Other stored values are sent to a multiplexed digital-to-analog converter to provide analog control signals. A transmitter at ion source potential transmits discrete status information and several channels of analog data from an analog-to-digital converter back to the ground-potential receiver where it is stored to be read and displayed by the software.

Motivation

The negative ion source test facility (NISTF) will be used to develop and test ion sources for the Holifield Heavy Ion Research Facility's (HHIRF) 25 MV tandem electrostatic accelerator. Each ion source will require its own set of power supplies. All of the power supplies will be voltage programmable, since they must be compatible with the HHIRF tandem's computer control system. In addition, it is necessary to obtain accurate readings of the various parameters of the ion source under development. These constraints of flexibility and accuracy are best met by a computer control system. An added attraction is the possibility of automating some of the routine testing and data-taking.

Although several small computer systems are presently available for perhaps a lower initial price, a CAMAC-based system is a better choice for this application for at least two reasons: 1) It is a widely used standard with several active vendors, and 2) the HHIRF tandem control and data acquisition systems are CAMAC-based, affording the benefits of local design and maintenance expertise.

Hardware

A diagram of the control system is shown in Figure 1. It shows an ORNL-designed shaft encoder module and a digital transmitter/receiver consisting of a CAMAC module in the ground-potential CAMAC crate linked via four optical cables to a chassis at ion source platform potential. The other interface contains circuitry for up to three shaft encoder inputs. Purchased CAMAC modules include a Kinetic Systems Model 3880 microcomputer, based on the Intel 8080 microprocessor, along with modules interfacing the microcomputer with the CAMAC crate control stations, a touch panel display driver (Kinetic Systems

Model 3235) and various A/D, D/A and digital I/O modules to control ground-potential equipment.

Digital Transmitter/Receiver

A block diagram of the digital transmitter/receiver is shown in Figure 2. Data is written to 32 subaddresses in the CAMAC module utilizing the four CAMAC subaddress (A) lines and both station (N) lines for the two-wide module. Parity and framing bits are added to the data and address information, and transmission is enacted over the optical link. Correct or incorrect reception is indicated by the response line. In the case of an incorrect reception, the information is re-transmitted automatically. Four re-transmissions are made before a LAM is raised to indicate failure. Another LAM signals a complete transmission.

Remote Chassis Circuitry

The received subaddress is used to define a memory location for storage of the received data. The stored data is selected and routed to the multiplexed digital-to-analog converter or the digital latches by an asynchronous memory address generator.

Another memory address generator in the ion source platform electronics addresses and strobes the 32-channel analog-to-digital converter. Address, parity and framing are appended to the 12-bit result of the conversion, or to data from the digital latches, and transmission is made back down to the ground-based CAMAC module where the data is stored. Memory locations may be read via the dataway in any order.

Shaft Encoder

The shaft encoder CAMAC interface module performs an up/down count of pulses from three shaft encoders. The three counters are 12 bits wide with the sign extended to 16 bits to reduce software overhead. Reading a particular shaft encoder's counter resets the counter. For convenience in quickly turning up devices with very fine resolution, a coarse switch increases the number of counts/revolution by a factor of four.

Touch Panel Display

The touch panel display is a Kinetic Systems Model 5209. The screen of the touch panel display is divided into 16 areas. Touching one of these areas activates a capacitive switch, and a number describing the location of the switch can be read from the CAMAC module controlling the display. This scheme is the basis for an operator-interactive display onto which an array of selections can be displayed. The operator may indicate a particular item by simply touching the area over one item on the display.

Software

A flow chart of the program is shown in Figure 3. Utilizing the touch panel, the operator may assign the shaft encoder to control any analog output device. To change an assignment, the operator touches the square containing the current shaft encoder assignment label. This causes the assignment to be changed to the next output device in the current list of output devices.

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Touching this area of the screen when the last device in the list is displayed causes an assignment to the device at the top of the list. Six lists of output devices, termed "sequences", are implemented. The first sequence contains every output device. Other sequences contain subsets of all the available output devices so that the operator may perform common operations, which involve sequencing through only a few adjustments, more conveniently. The current sequence is selected by pressing one of six switches above the touch panel display.

The assignment of the assignable switch is changed in a manner similar to the shaft encoder assignment. The difference is that only one sequence is implemented.

The principal constraint resulting in the structure of the software is the time required to perform conversion of the raw input data to meaningful display data, and the time required to update the display. Accordingly, the shaft encoder and assignable switch are serviced in a clock interrupt service routine, and only changing input data are converted and displayed in whatever time is not used by the clock service routine.

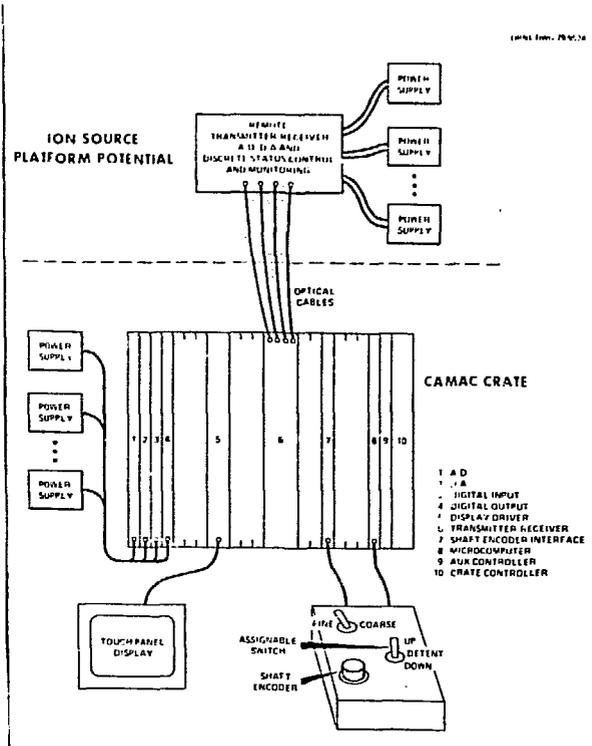


Figure 1. System Diagram

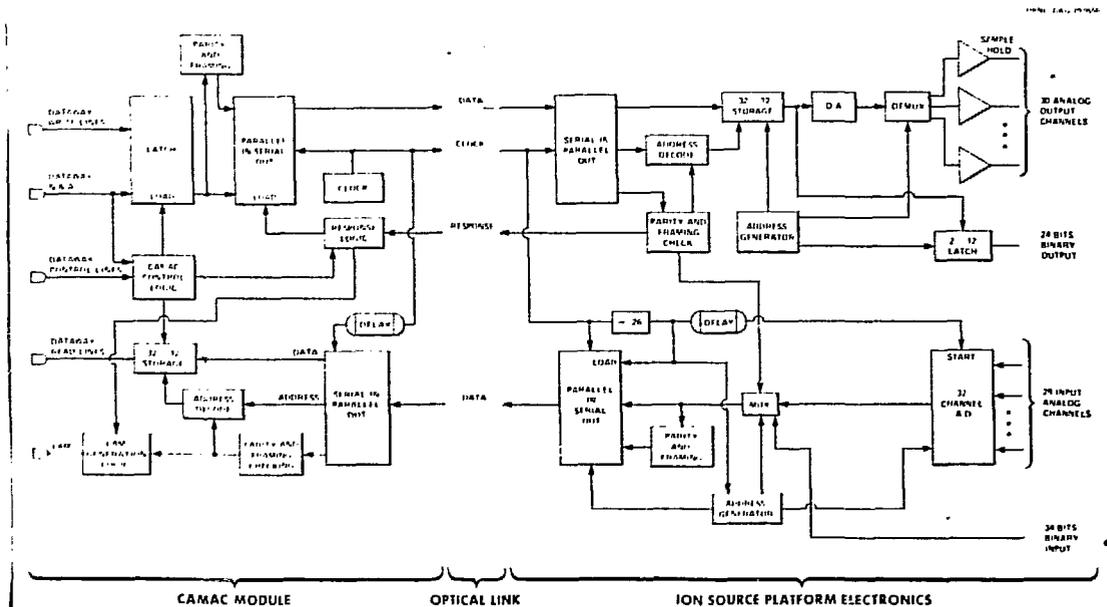


Figure 2. Transmitter/Receiver Block Diagram

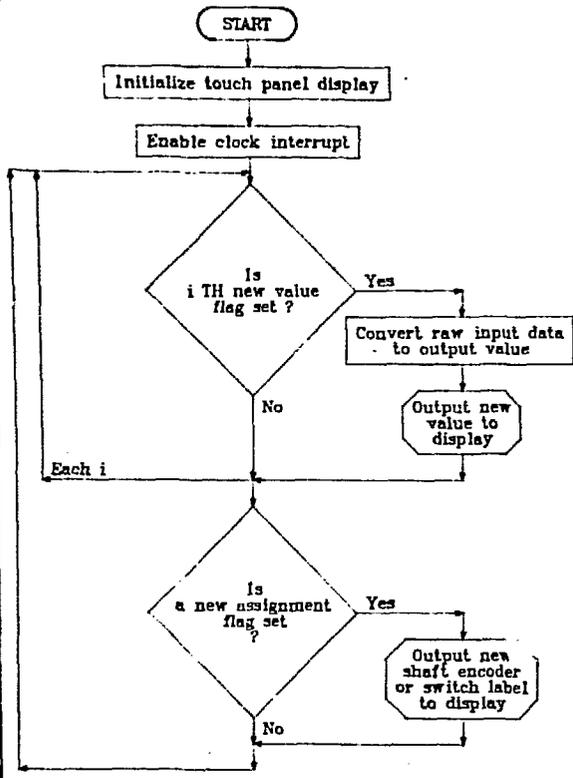


Figure 3a. Software Flow Chart

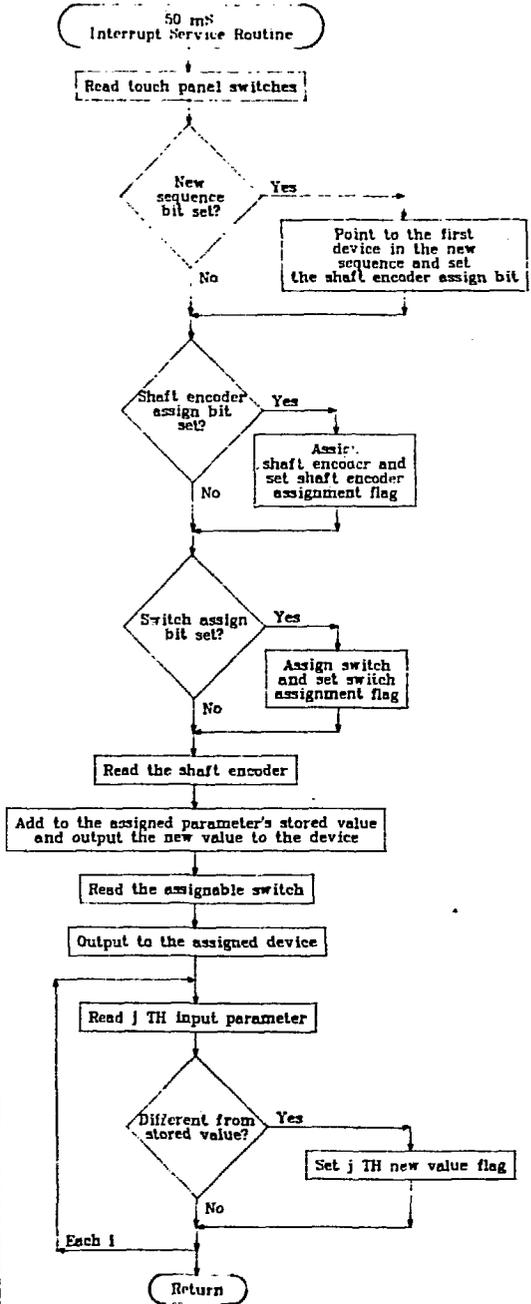


Figure 3b. Software Flow Chart