A CAMAC-BASED KNOB CONTROLLER FOR THE LAMPF CONTROL SYSTEM

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Abstract

The control computer for the Los Alamos Meson Physics Facility (LAMPF) has been recently upgraded from an SEL-840 to a VAX 11/780 running the VMS operating system. As part of this upgrade, a CAMAC-based knob controller was developed for the new control system. The knobs allow the facility operators to have slew control over software selectable accelerator devices. An alphanumeric display associated with each knob monitors the progress of the selected device. This paper describes the system requirements for the new LAMPF knob controller, and the resulting hardware and software design.

INTRODUCTION

The central control room at LAMPF is the hub from which thousands of analog and digital command and data channels are selected under software control for the purpose of controlling and monitoring the accelerator. The control system through which this is accomplished is based on a VAX 11/780 running the VMS operating system. One of the human-oriented interfaces to this control system is a CAMAC-based knob controller, which is the topic of this paper.

An operator console may have six slew knobs that can be assigned to any of approximately one thousand analog stepper motor-channels. The channel identifier and the present analog value of the channel being controlled are displayed on an eighty-character vacuum fluorescent display associated with each knob. The knob software enables LAMs for a knob when a channel is assigned to it. As the knob is being turned, counts are accumulated in a pulse-count register and a CAMAC LAM is generated every two hundred milliseconds. When a LAM is generated, the software reads the controller-status register to determine which knob is being turned. The control computer then responds to the LAM by reading the pulse-count register, routing the counts to the appropriate stepper-motor channel, and setting the pulse count register back to zero. The control computer also reads the analog data channel associated with the stepper motor and outputs this information to the knob controller RAM at CAMAC speed. An "End-of-Message" command will cause the RAM contents to be transferred to the display at 10 microseconds per character. Once the display has been updated, another LAM is asserted to inform the control computer that the message transfer is complete.

When the operator no longer needs a knob assigned to a given channel he can push a "clear assignment" button which will generate a third LAM. The software then places the knob and display in a "not assigned" mode.

The knob software can distinguish between the three types of LAM–knob slew, display update complete, and clear assignment – by reading the knob-status register.

HARDWARE

The knob-controller hardware consists of a CAMAC dataway buffer module and a knob-controller chassis which are interconnected with two sixty-foot cables. All of the logic for each knob and display is independent of all other knobs so that each knob can perform separate, simultaneous, control functions. Each knob has a scale factor for coarse, medium, or fine control of a channel as well as a single-step function switch. The programmable logic for each knob and display consists of a sixteen-bit up/down counter, a diagnostic register, a 256 x 8 RAM for the display, a knob status register, and the LAM logic. Controller registers include a knob-select register, a controller-ID register, and a controller-status register. All CAMAC functions occur within the one-microsecond dataway cycle time.

The knob is coupled to a quadrature, optical-incremental shaft encoder whose rotation direction is decoded in a PAL. The counts are accumulated in a 16-bit up/down counter with overflow detection. While the knob is being turned a slew LAM is generated every 200 milliseconds. An LED that is located above the knob serves as feedback to the operator that the computer is responding to the slew LAM being generated.

The display is an 80-character, two-line, alpha-numeric vacuum fluorescent readout with a character set of 256. The display has a RAM placed at it's front end for holding the message from CAMAC. After the control computer has sent the message to the RAM then an "end-of-message" command causes the RAM contents to be dumped to the display at 10 microseconds per character. When the transfer to the display is complete then a LAM is generated to indicate that the display update has completed.

Figure 1 is a block diagram that shows the data flow for one of the knobs and displays. The knob select register or knob mask register selects which knob and display will be connected to the control computer at any given time. The display utilizes CAMAC write lines W16-W9 for the address of the display with write lines W8-W1 as the ASCII data to be written into the display.

SOFTWARE

The knob software consists of two programs: a "knob driver" and a "knob symbiont." The knob driver handles the basic functions of writing to the knob display panel, reading the pulse count register, and handling LAMs from the knob controller. The knob symbiont is the program that connects a knob to an accelerator device.

The knob driver is a standard VMS device driver with a few modifications so that it may coexist with the LAMPF CAMAC driver. The crate controller used in the LAMPF control system is a Kinetic Systems KS3912 which maps each slot in the CAMAC crate into 16 words (one for each CAMAC sub-address) on the Unibus I/O page. The KS3912 can also be strapped so that the LAM from each module will interrupt through its own unique interrupt vector. The result is that the knob driver sees the knob controller module as just another Unibus device with 16 control/status registers and a single interrupt vector. In addition, the LAMPF CAMAC driver views the entire CAMAC crate as a single device (with 384 registers). This arrangement allows us to have two paths of access to the knob controller module – either through the knob driver or through the CAMAC driver. Most application programs access the knobs through the knob driver since this is the fastest way to get a knob to perform a desired function. Our diagnostic software, however, uses the CAMAC driver to issue specific FCNA commands to the knob controller module.

When a knob controller module is connected to the knob driver, the knob driver compares the controller's starting register address with the register spaces of all known CAMAC crates in the system in order to identify which crate the con-

troller module belongs to. This is done for two reasons; 1) to properly synchronize commands to the knob controller with other CAMAC activity, and 2) to properly dismiss LAM interrupt.

The knob symbiont program is responsible for keeping track of which knob is assigned to which accelerator device, for monitoring the current value of the assigned devices, and for displaying these values on the knob display panels. When an operator or a program wishes to assign a knob to an accelerator device, a request is sent to the knob symbiont. The knob symbiont then allocates a free knob, displays the name of the accelerator device on the knob display panel, and begins monitoring the value of the device. When the knob is turned, the knob symbiont reads the pulse count register and sends the accumulated pulses to the appropriate accelerator device. In order to provide good knob response time with minimal system overhead, the knob symbiont updates the display panels at two different rates. While a knob is being turned, the knob symbiont will update the display at a rate of 5 times per second. The update rate will drop to once per second after the knob has been idle for two seconds.

KNOB STATUS REGISTER FORMAT

Dataway Bit
16 - Error
14 - Overflow in Pulse Count Register
12 - RAM Busy - sending data to display from RAM
11 - Transmit Busy - Writing data to RAM from CAMAC
8 - Coarse
7 - Medium
6 - Fine
4 - LAM 3 - Display Update Complete
3 - LAM 2 - Clear Assignment
2 - LAM 1 - Slew
1 - LAM Enable

CONTROLLER STATUS REGISTER FORMAT

Dataway Bit
16 - Error
12 - RAM Busy
11 - Transmit Busy
4 - Knob 3 LAM Set
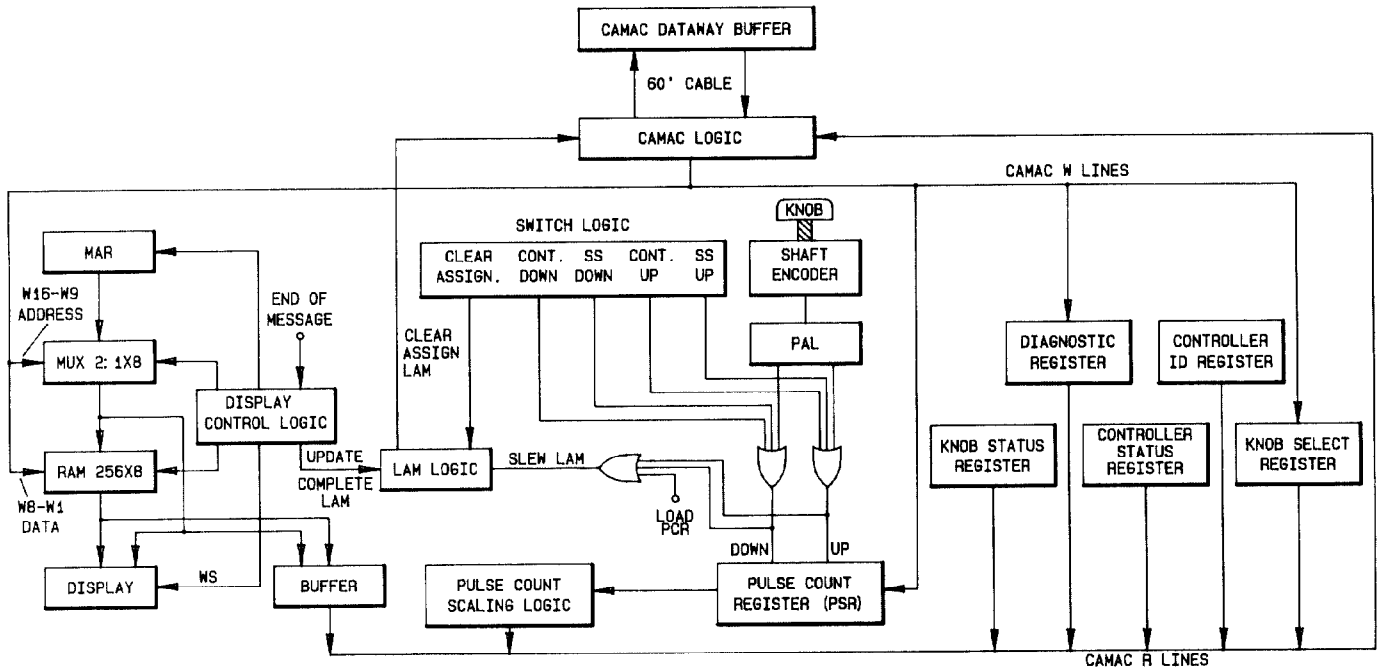3 - Knob 2 LAM Set
2 - Knob 1 LAM Set
1 - Controller LAM Enable

Fig. 1 Block Diagram of CAMAC Base Knob Controller.

545

CAMAC KNOB CONTROLLER COMMANDS

COMMAND	FUNCTION
F(0) A(0)	Read Knob Mask Register.
F(16) A(0)	Write Knob Mask Register.
F(0) A(1)	Read Pulse Count Register of selected knob.
F(16) A(1)	Write Pulse Count Register of selected knob. LAM 1 will be generated if enabled.
F(0) A(2)	Read Status Register of selected knob.
F(0) A(4)	Read one character from selected knob display RAM and increment RAM address-(MAR-BITS 16-9, Data-Bits 8-1).
F(16) A(4)	Write one character to selected knob display RAM. Bits 16-9 are address and bits 8-1 are data. Transmit Busy (CSR bit 11) will be set.
F(0) A(5)	Read Unit Diagnostic Register of selected knob.
F(16) A(5)	Write Unit Diagnostic Register of selected knob.
F(0) A(6)	Read Controller Status Register.
F(0) A(7)	Read Controller Module ID Register.
F(9) A(0)	Initialize Controller - Clears controller LAM enable and the Knob Mask Register.
F(9) A(1)	Initialize selected knob - Clears selected Knob Pulse Count Register and Overflow, clears LAMs 1,2,3 of selected knob; clears selected knob MAR, Transmit Busy RAM Busy, selected LAM enable, and enables serial input to the selected Pulse Count Register.
F(9) A(2)	Clears selected knob display MAR, Transmit Busy and RAM Busy.
F(10) A(1)	Clear selected knob LAM 1 (slew LAM)
F(10) A(2)	Clear selected knob LAM 2 (clear assignment LAM)
F(10) A(3)	Clear selected knob LAM 3 (display update complete LAM)
F(11) A(1)	Clear Pulse Count Register of selected knob and clear Overflow.
F(24) A(0)	Disable controller LAM.
F(26) A(0)	Enable controller LAM.
F(24) A(1)	Disable selected knob LAM.
F(26) A(1)	Enable selected knob LAM.
F(24) A(2)	Disable serial input to selected Pulse Count Register.
F(26) A(2)	Enable serial input to selected Pulse Count Register.
F(25) A(0)	End of message. Data will be transferred from the RAM to the display and RAM Busy (CSR Bit 12) will be set Transmit Busy (CSR Bit 11) and the MAR are cleared. RAM Busy will be cleared after the data is transferred to the display.
F(25) A(1)	Pulse the LAM 1 Acknowledge LED of the selected knob.
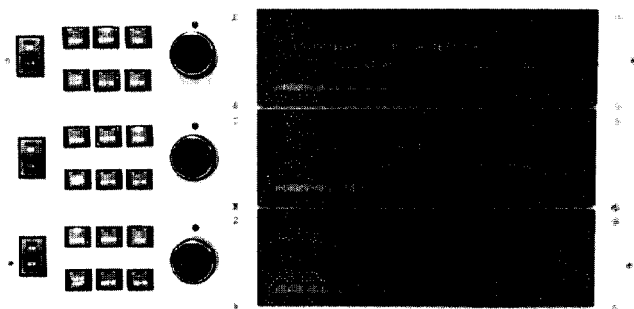
Knob Controller Front Panel

SUMMARY

The CAMAC knob controller has proven to be an efficient means for adjusting remote setpoint devices at LAMPF. The CAMAC standard was utilized for the design of the controller for ease in interfacing to the computers for control applications and maintenance purposes.

546