Upgrades to Control Room Knobs At SLAC National Accelerator Laboratory

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Introduction

For years, accelerator operators at the SLAC National Accelerator Laboratory (SLAC) have favored hardware knobs in the control room for accelerator tuning. Hardware knobs provide a tactile, intuitive, and efficient means of adjusting devices. The evolution of separate control systems for different accelerator facilities at SLAC has resulted in multiple flavors of knob hardware and software. To improve efficiency, space usage, and ease of use, the knob systems have been upgraded and integrated.

Project

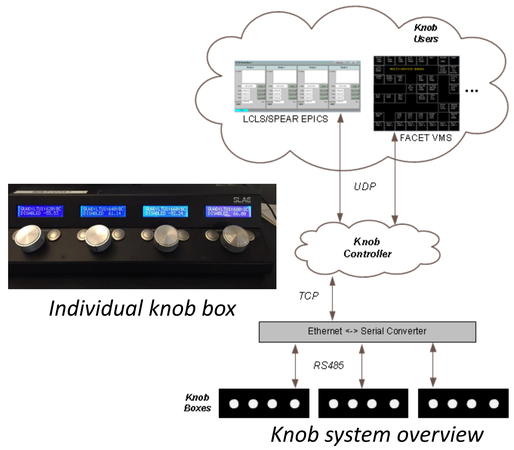
- Integrate new and legacy knob hardware and software
- Allow knob hardware to be shared by multiple control systems

Design Considerations

- Backward compatibility
  - Support existing communication protocols
- System performance and features
  - Good knob resolution
  - Quick response
  - Sharing devices without conflict
  - Ability to restore device to original value
- Enhancements
  - Single knob box can be used with multiple control systems simultaneously
- Maintainability
  - Modular software design to facilitate future protocol changes
- Flexibility
  - Distributed EPICS control system requires software to handle attachment of any device
  - Facility-specific conventions and device specific settings should also be supported

System Overview

- Knob Controller handles communication with hardware knob boxes
- Knob Users are control systems which assign devices to knobs
- Controller and knob boxes together act as server to Users
- Knob boxes use serial RS-485 protocol
- Controller and Users use UDP/TCP
- Each knob box has four knobs
- Each Controller can support 16 knob boxes



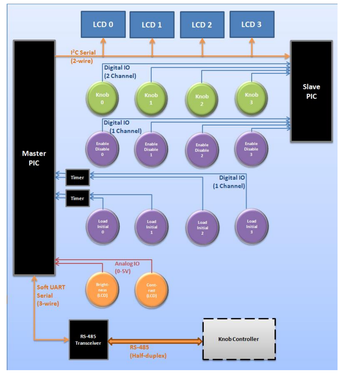
Individual knob box

Knob system overview

Hardware

The new hardware design is a small desktop unit. It has four knobs, each with:

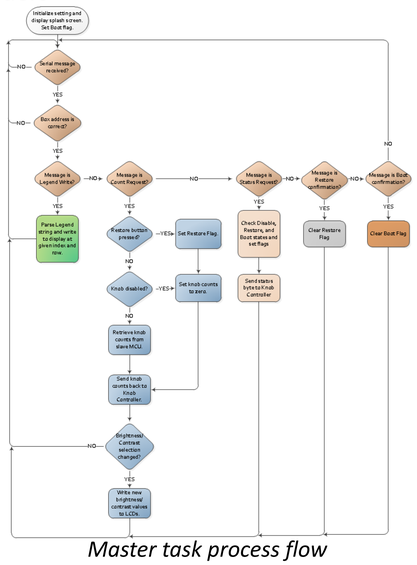
- LCD display
- Disable/enable button
  - Latching toggle switch
  - Turn counts are 'zeroed' while knob disabled
- Restore button (set device to original value)
  - Momentary switch coupled to 555 timer integrated circuit
  - Causes 'restore' flag to be sent to Controller



Knob box hardware block diagram

The knob box has two main tasks, each executed by a PIC16F1937 microcontroller

- Master task handles communication with Knob Controller, LCD displays, and slave microcontroller
- Slave task dedicated to counting rotational ticks and determining direction from knob optical encoders



Master task process flow

Software

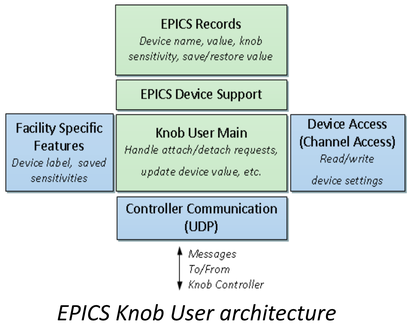
Knob Controller and EPICS Knob User are software processes running on Linux servers

- 'C' code running in context of EPICS IOCs

Legacy Knob User uses 'C' and Fortran software running on an Alpha.

EPICS Knob User

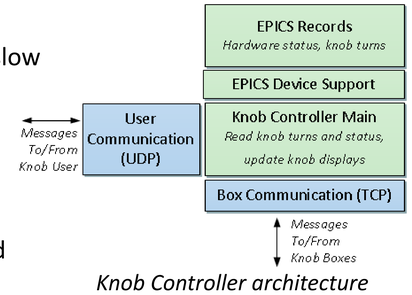
- Provides GUI for attaching and detaching devices
- Knob sensitivity adjustment and save
- Device value save and restore



EPICS Knob User architecture

Knob Controller

- Handles communication with hardware knobs
- Multi-threaded
  - One thread per knob box to handle slow serial communication with knobs
  - Additional single thread to process requests from Knob Users
- Each knob can have a different User
  - When new device attached to knob, Controller saves User information and notifies previous owner
  - Besides attach, any request not from knob owner is ignored



Knob Controller architecture

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