Peripheral Board Emulator  
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### Background

SEL desired to create a new internal-use product for their 4xx series relays, which would provide a new method to test and verify the functionality of their relays at all stages of product life. Previously, SEL’s test methods for diagnosing relays were very time consuming. Our designed final product has eliminated a great portion of the time required to set up an SEL relay for testing and analyze the results.

### Parts of a Relay

- **Mainboard:** Interfaces with all peripheral boards. Uses information gathered to perform operations vital to relay functionality.
- **Human Machine Interface (HMI):** The main method of communication between the user and the relay. Consists of an LCD screen, serial port, LEDs, and push-buttons.
- **Analog Input (CAL):** Used to monitor analog input signals.
- **Digital Input/Output (INT):** Serves as the relay processor’s interface to external devices. Converts high voltage input signals to logic supported by the mainboard. Can assert high voltage outputs based on user settings.

### Objectives

- Emulate the operation of the relay’s peripheral boards such that a mainboard would not be able to distinguish if the connected board was real or emulated
- Is supported by a scripting language that can easily manipulate the relay and simulate peripheral I/O events
- Is a fraction of the size and weight of a standard peripheral board
- Costs less than $25 to produce

### Final Product

![Diagram of Final Product]

- **Dual Port RAM**
- **EEPROMs**
- **Micro USB 2.0**
- **PSoC 5LP**
- **Connectors to Relay**

### Hardware Design

- Interfaces to relay compatible with current and legacy SEL mainboard variants
- Cypress PSOC 5LP, in conjunction with DPRAM and EEPROMs, provides means to change emulator board appearance and stimulate I/O
- User controlled via UART or USB 2.0 virtual COM port
- Pictured hardware was designed over the course of two semesters and manufactured by SEL

### Software Design

- Full-featured software engine capable of running with, or without, human intervention
- Mechanisms to check state of, or manipulate, relay I/O
- Custom scripting language to quickly perform emulator board commands, execute macros, and repeatedly execute automated tests
- Intelligent self-debugger to help troubleshoot hardware problems without external resources

### System Benefits

- Shortens feedback loops for rapid testing, verification, and development

### Glossary of Terms

- **Relay:** Power system protective device
- **PSoC:** Programmable System-on-Chip
- **EEPROM:** Electrically Erasable Programmable Read-Only Memory

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### Team Jaguar