Enigma18

B5: Nancy Anderson, Amelia Lobo, Tanisha Sethi
18-500 Capstone Design, Spring 2025
Electrical and Computer Engineering Department
Carnegie Mellon University

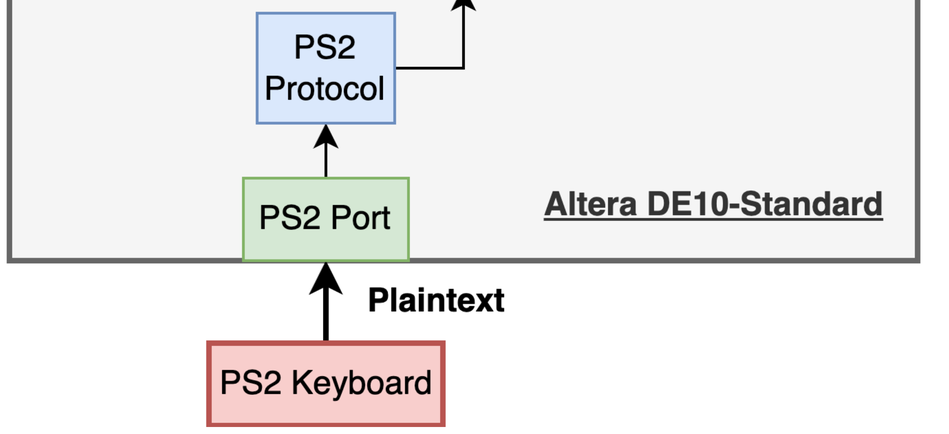
Product Pitch

Modernized implementation of the WWII **Enigma machine** developed as an exhibition piece to educate on cryptography

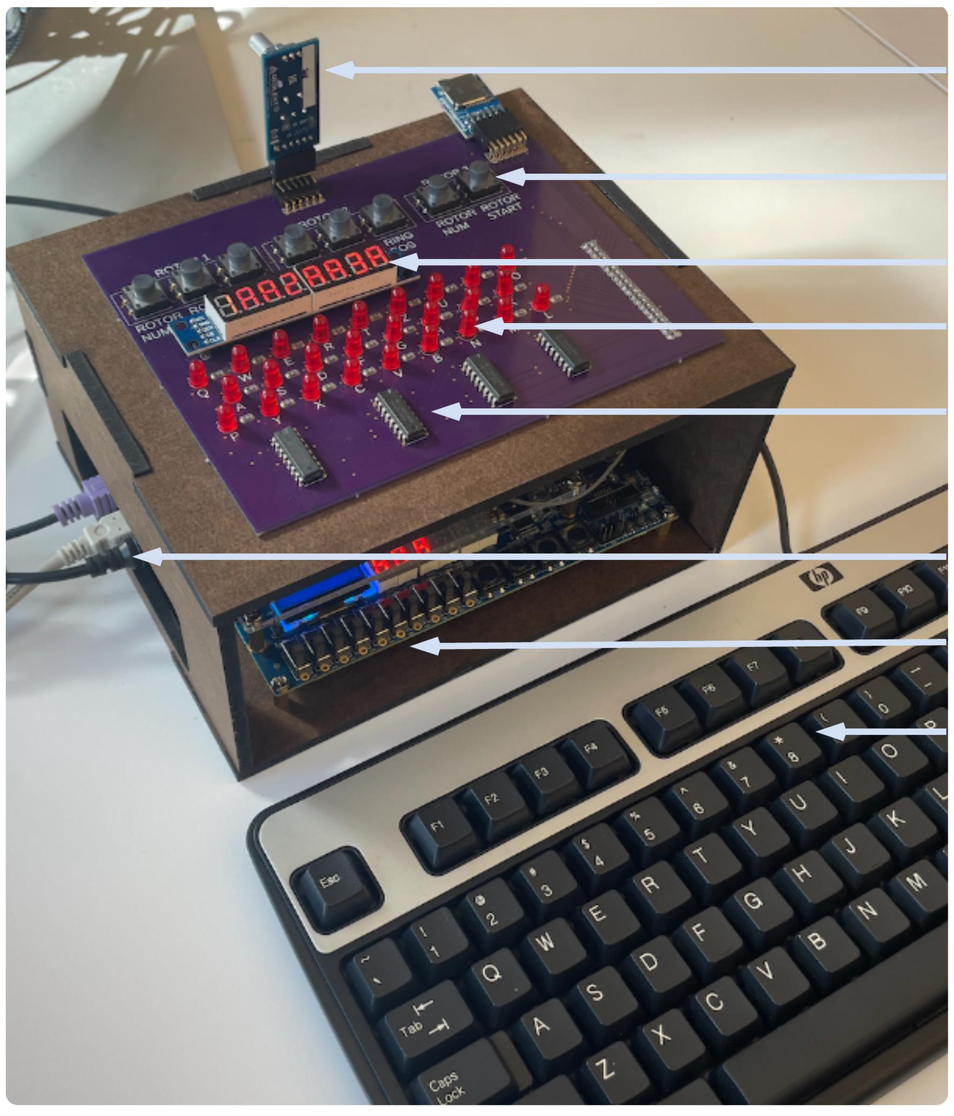
- Computation handled on Altera DE10-Standard **FPGA**
- I/O handled on **Custom PCB**
- Hands-on encryption and decryption
- Use in museums and classrooms; **compact** + **open-source**

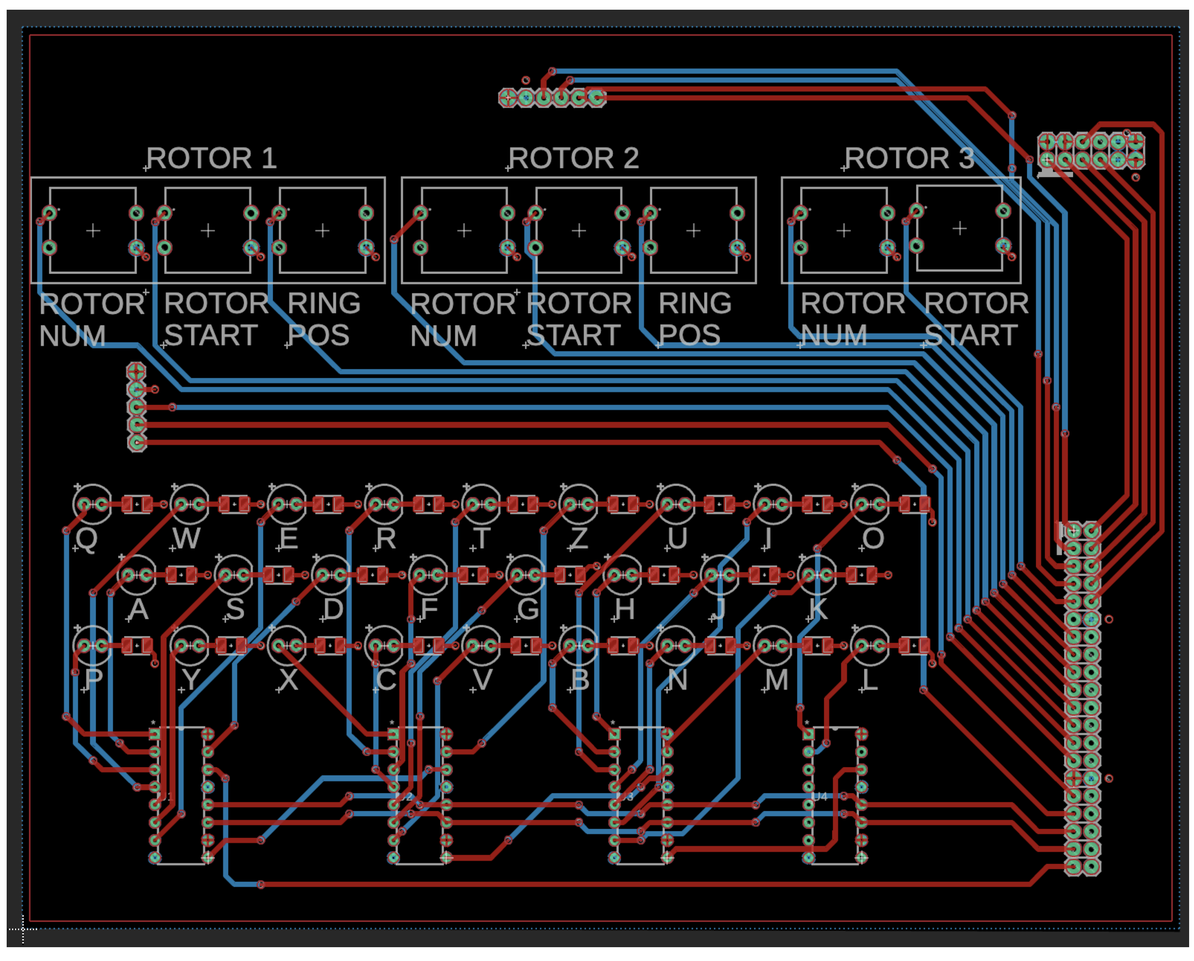
System Architecture

- Plaintext sent from PS/2 keyboard to DE10-Standard FPGA through PS/2 protocol
- Configurable rotor number, rotor starting position, and ring position using rotary encoder and buttons
- Rotor settings displayed on MAX7219 seven-segment display through SPI protocol
- Ciphertext displayed on LED matrix lampboard using shift registers to minimize GPIO pin usage



Final Design





Custom PCB Layout

System Evaluation & Verification

AREA	TEST METHOD	RESULT
PCB Design	Design Rule Check	100% correctness
	Electrical Rule Check	100% correctness
PCB Fab	Continuity test	0 open circuits
	Voltage measurement	100% correctness
	Trace verification	Validated 100% traces
RTL Synth	Peripheral unit tests	100% success rate
	Integrated user tests	Tested on 12 people
	Keyboard CPM <= 100	100% encryption correctness
	Keyboard CPM 200-350	<60% encryption correctness
RTL Sim	Constrained random tests	100% success rate

Conclusions & Additional Information

Scan to see more information about our project!
https://course.ece.cmu.edu/~ece500/projects/s25-teamb5/

Electrical & Computer ENGINEERING
Carnegie Mellon