STM32 32-Relay Control System (FreeRTOS + Modbus RTU/TCP)

Tools: STM32F401, FreeRTOS, RS485, Modbus RTU/TCP

Overview: Designed a 32-relay controller capable of both local and remote operation through Modbus RTU/TCP, managed via multitasking under FreeRTOS.

Objectives

• Control multiple outputs efficiently.
• Implement reliable communication protocols.
• Ensure real-time performance.

Technical Approach

• Implemented FreeRTOS tasks for Modbus handling, relay control, and status monitoring.
• Developed Modbus RTU (RS485) and Modbus TCP interfaces.
• Used queue synchronization to manage relay updates.
• Designed relay board layout with optocouplers for protection.

Challenges & Solutions

Challenge: Data collision on RS485 bus
Solution: Introduced CRC checks and timing control.

Challenge: Task synchronization
Solution: Used FreeRTOS queues and semaphores for safe state handling.

Results

Stable multitasking operation with seamless Modbus communication under 1 ms scheduling.

Future Enhancements

Add web server for monitoring and manual control.