PCB Design and Firmware Development Requirements Document

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1. Project Overview

The goal is to create a robust PCB system for industrial automation comprising multiple modules controlled by an ESP32 microcontroller. The system will interface with various motors, loadcell transmitters, sensors, augers, and switches to perform specific tasks pertaining to monitoring weights and accurate material dispensing for such set weights.

Firmware and logic software will be developed to enable communication with an external system via USB-C or TCP/IP and execute commands.

2. PCB Specifications

PCB Main Board Module 2-1

- Microcontroller: ESP32
- Inputs:
    - 12 x Reed Sensors
    - RS485 for communication
    - Emergency Stop, Pause, Resume, and Restart buttons
- Input & Outputs:
    - 4 x Digital IO
    - 2 Analog IO
    - 2 x USB-C for programming and communication
    - Connecting to external RFID module
    - Ethernet TCP/IP
- Indicators:
    - LED lights (Red, Amber, Green)
- Display Interface:
    - Connectors for either a 0.91 inch OLED Display (IIC SSD1306 128x32) or a 3.5" TFT SPI (480x320)
- Interconnects:
    - PINs for connection to daughter boards (Modules 2, 3, 4, and PRS)

- Insert slot for additional Module

PCB Module ID 2-2 - Stepper Motor Interfacing Board

- Components:
  - 5 x Motor drivers suitable for 24V
- Isolation: All motor drivers to be electrically isolated

PCB Module ID 2-3 - BLDC Motor Module Board

- Components:
  - 10 x BLDC Motors (DC 24V 4A) with speed control
- Functionality: Speed controlled, with motor power isolation

PCB Module ID 2-4 - Servo Motor Controller Interfacing board.

- PCB Board module with 4 x RS485 ports and DIO PORTS to control external servo motor drivers. This module will connect to the main board with a socket slot cable. (A fully documented Datasheet with communication interfacing document will be provided)

PCB Module ID 2-PRS-1 Power Relay Switching

- Components:
  - 12 x Relay to control Solenoid switches (24V 5W)
  - 4 x Relays (DC 24V, 10 A)

PCB Power Module ID 2-PWR - 1/2/3/4 (Not included in scope)

- 230V 50Hz single phase to 24V - Isolated Power for BLDC Motor (5 outputs, each 24V, 4 amps)
- 230V 50Hz single Phase to Isolated Power for Stepper or Servo Driver Boards (5 Outputs, each 24V 5amps)
- 230V 50Hz single Phase to 24V Module ID2-PRS-1
- 230V 50Hz to 5V - Power distribution for ESP32 Mainboard and other modules (5V 5 Amps)

3. Firmware and Logic Software

Firmware Features:

- Motor Control: Ability to specify coordinates, speed (0-100%), and on/off state for motors. Move forward or reverse, and apply brake.
- Weight-based Control: Implement algorithms to control motor speed and stop motors based on the weight set for an individual weighing bowl or total weight (Please note that Weight values will be communicated through a third-party device using RS485).
- Monitor the rotation in stepper motors using data received from the external stepper motor driver device.
- Ability to set the single-axis coordinate for the movement of the servo or stepper motor.
- Stepper Motor Controller interfacing: Ability to send commands for Speed (0-100%), move to coordinate (X-axis), Rotate (0-360 degrees), Forward, Reverse, homing, Jog, Brake, Emergency stop and other standard commands as per server driver device) (Full documentation will be provided)
- Servo Motor Controller interfacing: Ability to send commands for Speed (0-100%), move to coordinate (X-axis), Rotate (0-360 degrees), Forward, Reverse, homing, Jog, Brake, Emergency stop and other standard commands as per server driver device) (Full documentation will be provided)
- Solenoid and Relay Control: Manage the solenoids and relays' state (on/off).
- LED Control: Manage the state and colour of LED indicators based on system status.
- User Interface: Handle inputs from emergency stop, pause, resume, and restart buttons. Reflect system status on displays.

Logic Software:

- USB-C Interface: Develop a protocol over USB-C for external software to send commands to the ESP32.
- Ethernet TCP/IP Interface: Develop a protocol over to interface for external software to send commands to the ESP32 using a TCP/IP.
- Command Processing: Implement command parsing and execution for motor movements, speed adjustments, and other control features.

4. Testing and Validation

- Simulation: Use software tools to simulate PCB designs and firmware to ensure correct functionality before hardware implementation.
- Prototyping: Build prototypes to test the integration of hardware and firmware.
- Functional Testing: Conduct thorough testing for each module to verify all specifications are met, including stress testing under various operational conditions.
- Compliance Testing: Ensure all designs meet relevant electrical and safety standards.
- Testing the hardware (including assembly and PCB testing with components). The testing shall include all functionality. For the purpose of clarity, the payment for components is not included in the current offer, and once you let us know the BOM, we will make payment separately).

5. Documentation

- Design Documentation: Provide complete schematics, BOM (Bill of Materials), assembly drawings, and layout files.
- User Manual: Create a detailed user manual covering operation, troubleshooting, and maintenance.
- Firmware Documentation: Document firmware architecture.

6. Deliverables

- **Schematic Designs:** Complete schematic designs for all PCB modules.
- **PCB Layout Designs:** Fully routed PCB layouts, adhering to industry standards and design for manufacturing (DFM) guidelines.
- **Bill of Materials (BOM):** A detailed list of all components, including manufacturers, part numbers, and quantities.
- **Firmware Source Code:** Well-documented firmware code for the ESP32.
- **Logic Software (Optional):** If applicable, provide logic software for the external system to communicate with the PCB.
- **Testing Documentation:** Results of functional and environmental testing to validate performance and reliability.

7. Timeline and Milestones

Develop a project timeline with milestones for design, prototyping, testing, and final delivery. Include regular review points to ensure project objectives are being met. We expect the complete handover in 45 days from the offer & acceptance.

8. Fees

TBF

9. Architecture Diagram