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, sensors, and switches to perform specific tasks. Firmware and logic software will be developed to enable communication with an external system via USB-C, RS-485 or TCP/IP , EtherCAT or CAN, MODBUS, or DIO, and execute commands.

2. PCB Specifications

PCB Contol Board Module 2-1

- Microcontroller: ESP32
- Inputs & Outputs - As shown on the Diagram
- 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 listed below)
    - Insert 2 x slots for additional ESP Module

PCB MTU Module ID 2-2 - Stepper Motor Module Board

- ESP32 Chip
- Design as shown in the Diagram in Annexure A
- 16 x Motor drivers suitable for 24V
- Isolation: All motor drivers to be electrically isolated
- PCB Board to interface with other servo drivers using
    - 1 x RS485 ports

- 1 x RS-232
- 1 x USB-C
- 8 x DIO PORTS
- 1 x EtherCAT (in/out)
- 1 x CAN
- A fully documented Datasheet with communication interfacing document is provided in the folder

  https://drive.google.com/drive/folders/1NZowpoqRifSqAT9oKxizvTUXsWfr5i5w?usp=drive_link

PCB MTU Module ID 2-3 - BLDC Motor Module Board

- ESP32 Chip
- Design as shown in the Diagram in Annexure A
- 16 (4 x 4) x BLDC Motors (DC 24V 4A) with speed control
- Isolation: All motor drivers to be electrically isolated
- Functionality: Speed controlled, with motor power isolation
- PCB Board to interface with other servo drivers using
  - 1 x RS485 ports
  - 1 x RS-232
  - 1 x USB-C
  - 8 x DIO PORTS
  - 1 x EtherCat
  - 1 x CAN
  - A fully documented Datasheet with communication interfacing document is provided in the folder

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PCB MTU Module ID 2-4 - Servo Motor Module board.

- ESP32 Chip
- IO, as shown in the Diagram in Annexure A
- 16 (4 x 4) x Servo Motor (with speed control
- Isolation: All motor drivers to be electrically isolated
- Functionality: Speed controlled, with motor power isolation

- PCB Board to interface with other servo drivers using
    - 1 x RS485 ports
    - 1 x RS-232
    - 1 x USB-C
    - 8 x DIO PORTS
    - 1 x EtherCAT (in/out)
    - 1 x CAN
    - 1 X ModBus
    - A fully documented Datasheet with communication interfacing document is provided in the folder

      https://drive.google.com/drive/folders/1NZowpoqRifSqAT9oKxizvTUXsWfr5i5w?usp=drive_link

PCB MTU Module ID 2-6 Solenoid Switching Module Board

- ESP32 Chip
- IO, as shown in the Diagram in Annexure A
- 16 (4 x 4) x Solenoid Switches (24V 5W)
- Isolation Power
- Functionality:
    - On/Off
    - Configurable for Normally Open (NO) or Normally Closed (NC)
- PCB Board to interface with other Modules using
    - 1 x RS485 ports
    - 1 x RS485 port for Modbus
    - 1 x RS-232
    - 1 x USB-C
    - 1 x DIO PORTS
    - 1 x EtherCAT (in/out)
    - 1 x CAN
    - 1 X ModBus
    - A fully documented Datasheet for Manifold interfacing document is provided in the folder

      https://drive.google.com/drive/folders/1NZowpoqRifSqAT9oKxizvTUXsWfr5i5w?usp=drive_link

PCB MTU Module ID 2-6-1 (12V,24V,48V) Relay Switching Module Board

- ESP32 Chip
- Design as shown in the Diagram in Annexure A
- 16 (4 x 4) x Relay (Switchable 12V, 24V, 48V - 12W)
- Isolation Power
- Functionality:
    - On/Off
    - Configurable for Normally Open (NO) or Normally Closed (NC)
- PCB Board to interface with other Modules using
    - 1 x RS485 ports
    - 1 x RS-232
    - 1 x USB-C
    - 1 x DIO PORTS
    - 1 x EtherCAT (in/out)
    - 1 x CAN
    - 1 X ModBus

PCB MTU Module ID 2-6-2 (110V - 240V 10Amp) Relay Switching Module Board

- ESP32 Chip
- Design as shown in the Diagram in Annexure A
- 16 (4 x 4) x Relay (110-240V 10A)
- Isolation Power
- Functionality:
    - On/Off
    - LED Light support
    - Dimming
- PCB Board to interface with other Modules using
    - 1 x RS485 ports
    - 1 x RS-232
    - 1 x USB-C
    - 1 x DIO PORTS
    - 1 x EtherCAT (in/out)
    - 1 x CAN
    - 1 X ModBus

PCB Power Module ID 2-PWR - 1/2/3/4

- 110V - 240V 50Hz single phase to 24V - Isolated Power for BLDC Motor (4 outputs, each 24V, 4 amps)
- 110V - 240V 50Hz single Phase to Isolated Power for Stepper or Servo Driver Boards (4 Outputs, each 24V 5amps)
- 110V - 240V 50Hz single Phase to 24V Module
- 110V - 240V 50Hz to 5V - Power distribution for ESP32 Control Board 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 or apply brake.
- Weight-based Control: Implement algorithms to stop motors based on the weight detected for an individual 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.
- 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, RS-485, RS-232 or CAN Interface: Develop a protocol over USB-C, RS-485, RS-232 or CAN or ModBus for interfacing with external devices and sending and receiving commands.

- Ethernet TCP/IP Interface: Develop a protocol over TCP/IP for interfacing with external devices and sending and receiving commands.
- EtherCAT Interface: Develop a protocol over EtherCAT for interfacing with external devices and sending and receiving commands.
- Command Processing: Implement command parsing and execution for motor movements, speed adjustments, and other control features related to MTU functionality.

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

USD 2,550

9. Architecture Diagram

https://drive.google.com/file/d/1RYMW1zY6EFuZb_7kMPxGYOTbJUGr62xa/view?usp=sharing

10. All relevant documents

https://drive.google.com/drive/folders/1Pi4TDG_O2nJVFrFzQsSyu7NSZnQ9FdJt?usp=sharing