Brushless Motor Tester - Component Architecture

System

Overview

The brushless motor tester is a modular system for testing and characterizing brushless motors in the 1,000-28,000 Kv range, powered by an external bench supply (0-18V, 0-40A) with integrated measurement, control, and data logging capabilities.

Hardware Component Architecture

1. Power Management Module (PMM)

Responsibilities:

- Accept external bench power supply input (0-18V, 0-40A)

- Voltage and current limiting protection
- Power distribution to motor controller and measurement systems
- Optional regenerative braking circuit (0-20A sink capability)

Interfaces:

- Input: Banana plug connectors for

bench supply

- Output: Power rails to motor controller and measurement boards
- Control: I2C/SPI to main controller for limit settings

Key Components:

- Input protection circuitry
- Programmable voltage/current

limiters

- Braking resistor circuit with MOSFET control
- Current sense resistors

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2. Motor Controller Interface (MCI)

Responsibilities:

- Interface with standard eCom

(Remora primary, others optional)

- Drive motor phases (U/V/W)
- Provide throttle control input (slot car controller compatible)
- Extract telemetry data via WiFi/serial

Interfaces:

- Motor output: Standard phase

connectors (U/V/W)

- Throttle input: Banana plugs for slot car controller
- Data: WiFi/UART to main controller
- Power: From PMM

Key Components:

- Remora eCom (or compatible ESC)
- Connector board for standardized interfaces

- Signal conditioning for throttle input

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3. Measurement & Sensing Module (MSM)

Responsibilities:

- Measure all voltage and current parameters
- Detect motor speed (hall effect/optical)

- Measure phase resistance and inductance
- Interface with optional thermal sensors

Interfaces:

- Voltage sense: Input voltage, motor voltage
- Current sense: Input current, motor current, braking

current

- Speed sensing: Hall effect/optical sensor outputs
- Thermal: Thermocouple/IR thermometer interface (optional)
- Data: SPI/I2C to main controller

Key Components:

- High-side current sense amplifiers

(INA219 or similar)

- Voltage dividers with ADC protection
- Hall effect sensor (e.g., A3144) or optical sensor
- ADC multiplexer
- Precision references

Sub-modules:

- **Speed Sensor Assembly:**

Mounting bracket for hall/optical sensor near motor shaft

- **Thermal Interface Board:** K-type thermocouple amplifier (optional)

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4. Main Control Unit (MCU)

Responsibilities:

- Coordinate all

system operations

- Execute test profiles
- Data acquisition and logging
- User interface management
- Calculate derived parameters

Interfaces:

- Communication buses: I2C, SPI, UART to all

modules

- Display interface: SPI/I2C for screen
- Storage: SD card or flash memory
- USB: For data export and configuration
- WiFi (optional): For remote monitoring

Key Components:

- Raspberry Pi Pico or similar MCU with

DAC

- Real-time clock for timestamping
- SD card module
- USB interface

Firmware Modules:

- Profile execution engine
- Data acquisition controller
- Calculation engine (Kv estimation, efficiency, etc.)

- Storage manager
- Communication protocol handler

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5. User Interface Module (UIM)

Responsibilities:

- Display real-time test data
- Allow profile configuration
- Test result browsing

- System status indication

Interfaces:

- Display: SPI/I2C connection to screen
- Input: Rotary encoder or buttons for navigation
- Indicators: Status LEDs

Key Components:

- LCD/OLED display (128x64 minimum, color TFT preferred)
- Rotary encoder with push button
- Status LEDs (power, test running, error)

Display Screens:

- Live monitoring view
- Profile

selection/configuration

- Results browser
- System settings

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6. Mechanical Fixture System (MFS)

Responsibilities:

- Securely mount motor under test
- Provide safety enclosure

- Accommodate various motor sizes
- Support synthetic loads (flywheel/propeller)

Components:

- 3D printed base enclosure
- Adjustable motor mounting plate
- Protective shield/cover
- Connector panel for

all external connections

- Cooling ventilation

Design Considerations:

- Modular motor mounts for different sizes
- Quick-release mechanism
- Transparent shield for visual monitoring

- Vibration damping feet

Software Component Architecture

1. Embedded Firmware (C/C++)

Modules:

- **HAL (Hardware**

Abstraction Layer): Driver interfaces for all hardware

- **Profile Manager:** Load, execute, and manage test sequences
- **Data Acquisition Engine:** High-frequency sampling and buffering
- **Calculation Library:** Motor

parameter calculations

- **Display Manager:** Screen rendering and UI state machine
- **Storage Manager:** File system operations for test results
- **Communication Stack:** USB, UART, WiFi protocols

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2. Data Export & Analysis (Python/Desktop Application)

Capabilities:

- Import CSV test results
- Generate comparison charts
- Calculate advanced metrics
- Export formatted

reports

- Gearing recommendations (Release 1+)

Components:

- CSV parser
- Plotting library integration
- Data analysis algorithms
- Report generator

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3. Configuration Tool (Optional - Release 1)

Capabilities:

- Create and edit test profiles on PC
- Upload profiles to device
- Firmware updates
- Calibration utilities

Data Architecture

Test Profile Format (JSON/Binary)

```
{
  "profile_name":
  "steps": [
    {
      "voltage":
      "duration_m
      "sample_rat
    },
    ...
```

```
  ],
  "motor_poles":
  "load_type": "n
}
```

Test Results Format (CSV)

```
timestamp,voltage
```