

Prototype Electrical & Control Requirements – Rev A (Working Outline)

Scope: Define the initial electrical, control, sensing, and data-logging requirements for the PHD MMP prototype (forced-plane configuration) as described in the MMP-Prototype and PT-Veloci-Propulsion documents.

Motor and Drive Control

Three BLDC motors (two propellers, one propeller-plane), nominal 1,000 W each, 220 V AC drivers as per Qiwo models referenced in the prototype docs.

Independent closed-loop RPM command and feedback for each motor; control range approximately 0–6,000 rpm (or 0–8,000/10,000 rpm, depending on final motor choice).

Ability to run pre-programmed RPM setpoint matrices (e.g., 2,000–5,000 rpm for each motor) and hold steady speed during each test point.

Basic protections: over-current, under-voltage, over-speed limits, and emergency stop input to shut down all drives.

Sensing and Instrumentation

Differential pressure: 2 channels, 5 kPa full-scale each, resolution on the order of 5–10 Pa, taps placed upstream and downstream of the propeller plane, sample rate 100–500 Hz.

Absolute pressure: 1 channel at bottom of shaft, 0–2 bar abs, similar 100–500 Hz logging.

RPM: 1 channel per motor (3 total), using Hall or optical pickup; digital pulses per revolution, logged at 100–500 Hz.

Thrust: 1 load-cell or scale channel covering approximately 0–10 kg thrust for the prototype mount, with stable reading during runs.

Optional: 1 temperature sensor per motor can (thermistor/RTD) plus 1–2 casing temperature points for thermal correlation.

Data Acquisition and Control Platform

Central controller: either a small single-board computer (e.g., Raspberry-Pi-class) with I/O HATs or an equivalent DAQ/controller capable of:

Reading ~8–10 analog/digital sensor channels at 100–500 Hz.

Driving digital/serial commands to the three motor controllers.

Time-stamped logging of all data (RPM, pressures, thrust, temperatures, state flags) to disk for later analysis.

Operator interface: simple screen/UI to load a test matrix, start/stop a test sequence, view key live values, and indicate fault conditions (E-stop, sensor failure, over-speed, etc.).

Safety and Power Segregation

Mains: 220 V AC feed sized for three 1,000 W drives, with appropriate breakers and emergency-stop contactor.

Segregated wiring: high-voltage motor/drive wiring routed separately from low-voltage sensor and control wiring; shielded cabling on all pressure and low-level signals.

Grounding: common protective earth for drives, casing, and control enclosure; star-point reference for low-voltage sensor grounding.

Interlocks: lid/cover interlock input (no run when open), thrust-stand overload detection, and defined safe state on any controller fault.

Test-Sequence Capability (First Article)

Support for the 32-point test matrix: combinations of propeller and propeller-plane RPM steps over the defined ranges, with configurable dwell time per point.

Automated logging for each point, including test ID, commanded speeds, measured speeds, pressures, thrust, and temperatures.

Basic post-test data export (e.g., CSV files) for further analysis of thrust vs. RPM vs. pressure.

Open items to finalize before detailed design

Final motor/driver selection and confirmed maximum RPM (6,000 vs 8,000/10,000).

Exact sensor part families and interfaces (I2C/SPI vs analog).

Choice of central controller platform (SBC + DAQ vs industrial PLC/motion controller).

Detailed safety philosophy for the prototype lab (who operates, acceptable risk levels, local standards).