What kind of passive cooling thermal profile regime am I looking at for a prototype PHD drive using the two 1000W 6,000 Rpm motors listed?

Se mina tankar
Good question—this is exactly the kind of thing you want bounded before you spin anything up.

1. Power, losses, and what actually turns into heat

For the Qiwo QW80BL00760-1000 motors:

- **Electrical input per motor (rated):** $\mathrm{Pin} \approx 1{,}000\ \mathrm{W}$
- **Likely efficiency band at 6,000 rpm:** $\eta \approx 0.85\text{–}0.9$ for a decent BLDC with proper commutation and load
- **Heat per motor:**

$\mathrm{Ploss} = \mathrm{Pin}(1 - \eta)$

- At $\eta = 0.9$: $\mathrm{Ploss} \approx 100\ \mathrm{W}$
- At $\eta = 0.85$: $\mathrm{Ploss} \approx 150\ \mathrm{W}$
- **Two motors (propellers only case):** $\mathrm{Ploss,\ total} \approx 200\text{–}300\ \mathrm{W}$

If you later run **all three motors** (two propellers + propeller plane) at or near rated power, you’re looking at:

- $\mathrm{Ploss,\ total} \approx 300\text{–}450\ \mathrm{W}$

That’s the heat load your passive/forced-by-airflow regime must reject.

2. Cooling modes you actually have in this prototype

You’re not in a “sealed brick” regime—you’ve got:

- **Internal forced convection:** The propellers and propeller plane are moving a lot of air through the inner shaft. That air is your primary coolant.
- **Conduction to structure:** Motor mounts, struts, and casing conduct some heat away from the motor housings.
- **External natural convection + radiation:** Outer carbon-fiber shell to ambient.

The dominant term is **forced convection from the internal airflow over the motor housings and mounts**.

3. First-order thermal estimate for motor surface temperature

Let’s treat each motor as a lumped body with:

- **Heat generation:** $\mathrm{Ploss} \approx 100\text{–}150\ \mathrm{W}$
- **Effective convective area exposed to internal flow:** Motor can + mount + nearby metal ≈ **$0.03\text{–}0.05\ \mathrm{m}^2$** (order-of-magnitude)

- **Internal air velocity:** At 4,000–6,000 rpm with a 0.4 m rotor in a duct, you can easily be in the **10–25 m/s** internal flow regime near the motors.
- **Forced convection coefficient (air, turbulent, 10–25 m/s):** $h \approx 50–150$ W/(m^2\cdotpK) is a reasonable band.

Then:

$\Delta T=PlosshA$

Take a mid-case:

- **Assume:** Ploss=120 W, A=0.04 m^2, h=80 W/(m^2\cdotpK)

$\Delta T \approx 12080 \cdot 0.04=1203.2 \approx 37.5 \circ C$

So for **each motor**:

- **Motor surface rise above internal air:** ~**30–50°C** is a realistic band at rated load with decent internal airflow.
- If ambient is **20°C** and internal air is maybe **+5–10°C** above ambient, you're looking at **motor surface temps in the 55–80°C range** under continuous full-load operation.

That's **well within typical BLDC continuous ratings**, but you're close enough that you want real data once built.

4. Internal air temperature rise in the shaft

Now treat the whole inner shaft as a duct with air picking up motor losses.

- **Total heat to air (two motors):** $Q \approx 200–300$ W
- **Mass flow rate:**

  For a 0.4 m rotor in a 0.42 m ID duct at 4,000–6,000 rpm, even with high-pressure/low-flow bias, you're not at tiny flow. A conservative starting point:

  - **Mass flow:** $\dot{m} \approx 0.1–0.3$ kg/s (this is deliberately conservative; real flow may be higher)
- **Air heat capacity:** $cp \approx 1,000$ J/(kg\cdotpK)

Then:

$\Delta Tair=Q\dot{m}cp$

Example:

- Q=250 W, $\dot{m}$=0.2 kg/s

$\Delta Tair \approx 2500.2 \cdot 1000=250200=1.25 \circ C$

Even if you're at the low end of flow:

- Q=300 W, $\dot{m}$=0.1 kg/s

$\Delta Tair \approx 3000.1 \cdot 1000=3 \circ C$

So **internal air temperature rise is small**—a few °C—because the motors are immersed in a strong forced-flow environment. That’s good news: the motors are basically sitting in a cool, fast-moving air bath.

5. Outer casing and “passive” regime

From the outside world’s perspective:

- **Total heat to reject:** 200–450 W (depending on how many motors you run hard)
- **Outer surface area of casing:**

  Cylinder, say **D ≈ 0.64 m**, **L ≈ 1.0–1.3 m**:

$Aouter \approx \pi DL \approx 3.14 \cdot 0.64 \cdot 1.1 \approx 2.2\ m^2$(order-of-magnitude)

- **Natural convection + radiation combined effective h:** For a warm vertical cylinder in still air: heff≈5–10 W/(m^2\cdotpK) is typical.

Then:

$\Delta Tcasing = QheffAouter$

Example:

- Q=300 W, A=2.2 m^2, heff=7 W/(m^2\cdotpK)

$\Delta Tcasing \approx 3007 \cdot 2.2 \approx 30015.4 \approx 19.5^\circ C$

So:

- **Outer casing rise:** ~**10–25°C** above ambient for 200–450 W total heat.
- At **20°C ambient**, casing sits around **30–45°C** in steady state—warm but not problematic.

6. So what “thermal regime” are you in?

Putting it together for the **two 1,000 W, 6,000 rpm motors** in your PHD/MMP prototype:

- **Heat generation per motor:** ~100–150 W
- **Total heat (two motors):** ~200–300 W (up to ~450 W if you add the propeller plane motor later)
- **Internal air:**
  - Temperature rise along the shaft: **~1–3°C** at plausible mass flows
  - Regime: **strong forced convection, turbulent, high Reynolds**
- **Motor surfaces:**
  - Temperature rise above internal air: **~30–50°C**
  - Expected steady-state motor surface: **~55–80°C** at 20°C ambient
- **Outer casing:**
  - Temperature rise above ambient: **~10–25°C**

    - Expected casing temperature: **~30–45°C** at 20°C ambient

So you're in a **comfortable passive/forced-convection regime**:

- No dedicated liquid cooling needed.
- No heatsinks beyond the motor housings and mounts are strictly required for initial prototype.
- The main risk is **local hot spots** if a motor is shielded from the main flow or if you run at high torque at low rpm (less internal airflow).

7. Practical next steps I'd bake into the prototype

If you want this to be "builder-proof" and data-rich:

1. **Add at least one thermistor/RTD on each motor housing.** Log vs RPM and current so you can map real thermal behavior.
2. **Ensure the motors are directly in the main flow path.** Avoid shrouds or wiring bundles blocking air around the can.
3. **Design mounts in metal, not composite, at least locally.** Let the mounts act as heat spreaders into the structure.
4. **Plan a derated continuous regime.** Treat "1,000 W" as **peak** and assume **600–800 W** electrical as your continuous design point until you have real thermal data.

If you want, we can do a more explicit thermal RC model (motor thermal mass, time constants, warm-up curve to steady state) so you get **time-to-overheat vs load** for your test matrix.

Run me through time-to-overheat vs load at 1000 W with two motors fully loaded at 6,000 rpm as in a PHD drive which only requires two motors what is my runtime?

Se mina tankar
You're basically asking: with both Qiwo motors at full 1,000 W electrical and 6,000 rpm in the PHD configuration, how long until the motors thermally saturate to a "don't-go-higher" temperature?

I'll give you a simple first-order thermal model you can actually use.

1. What turns into heat at "1,000 W per motor"

Per motor:

- **Electrical input:** $P_{in} \approx 1{,}000$ W
- **Efficiency band at 6,000 rpm:** $\eta \approx 0.85$–0.9
- **Losses (heat):**

$P_{loss} = P_{in}(1 - \eta) \approx 100$–$150$ W

I’ll use a **mid–worst case** for time-to-overheat:

- **Assume:** $Ploss=120–150\ W$ per motor

The two motors don’t heat each other much directly; each one’s thermal limit is essentially independent.

2. Thermal resistance and time constant assumptions

We don’t have Qiwo’s thermal RC data, so we have to pick realistic bands for a ~3 kg, 80 mm BLDC in strong forced airflow (your shaft flow):

- **Effective thermal resistance (winding→ambient air):** $\theta th\approx 0.7–1.0\ K/W$ (forced convection, metal mounts, not potted in foam)
- **Thermal time constant:** $\tau\approx 600–900\ s$ (10–15 min) for a few-kg metal body with decent airflow

These are conservative but not crazy for this geometry and airflow regime.

3. Steady-state temperature rise at 1,000 W electrical

For one motor:

$\Delta Tss=\theta th\cdot Ploss$

Take two bounding cases:

1. **Better cooling:** $\theta th=0.7\ K/W,\ Ploss=120\ W$

$\Delta Tss\approx 0.7\cdot 120=84\circ C$

2. **Worse cooling:** $\theta th=1.0\ K/W,\ Ploss=150\ W$

$\Delta Tss\approx 1.0\cdot 150=150\circ C$

With **ambient ~20°C**, that gives a **steady-state winding/shell band** of roughly:

- **Better case: ~100°C**
- **Worse case: ~170°C** (too hot)

Realistically, your forced shaft flow pushes you closer to the **better side**; otherwise the motor wouldn’t be sold as “continuous 1 kW” in free air.

Let’s pick a **working design band**:

- **Allowable motor temperature:** $Tlimit\approx 100–120\circ C$ (Class F/H winding)
- **Ambient:** $Tamb\approx 20\circ C$
- **Allowable rise:** $\Delta Tallow\approx 80–100\circ C$

4. First-order warm-up model and solving for runtime

Use a single-pole thermal RC:

$T(t)=Tamb+\Delta Tss(1-e-t/\tau)$

We want the time t when $T(t)=Tlimit$.

Rearrange:

$Tlimit-Tamb=\Delta Tss(1-e-t/\tau)$
$\Delta Tallow\Delta Tss=1-e-t/\tau$
$e-t/\tau=1-\Delta Tallow\Delta Tss$
$t=-\tau\ln(1-\Delta Tallow\Delta Tss)$

Case A – "Good cooling" (likely PHD reality)

- $\theta th=0.7\ K/W$
- $Ploss=120\ W$ → $\Delta Tss=84^\circ C$
- $\Delta Tallow=80^\circ C$ (20→100°C)
- $\tau=700\ s$ (≈12 min)

Then:

$\Delta Tallow\Delta Tss=8084\approx0.95$
$t=-700\ln(1-0.95)=-700\ln(0.05)\approx700\cdot3.00\approx2{,}100\ s$

- **Runtime ≈ 2,100 s ≈ 35 min** to reach ~100°C.

If you allow 110–120°C, you're essentially at or beyond steady state—i.e. **quasi-continuous**.

Case B – "Mediocre cooling" (more conservative)

- $\theta th=1.0\ K/W$
- $Ploss=150\ W$ → $\Delta Tss=150^\circ C$
- $\Delta Tallow=80^\circ C$
- $\tau=700\ s$

$80150\approx0.533$
$t=-700\ln(1-0.533)=-700\ln(0.467)\approx700\cdot0.76\approx530\ s$

- **Runtime ≈ 9 min** to hit ~100°C.

So depending on how good your actual convective coupling is, **time-to-100°C at full 1 kW per motor is roughly 10–35 min**.

5. What I'd treat as your design answer

For the **PHD drive with two 1,000 W motors at 6,000 rpm**:

- **Per motor losses:** ~120–150 W
- **Likely thermal regime in your shaft:** strong forced convection → closer to Case A than Case B
- **Practical runtime at full 1,000 W electrical:**
    - **Safe design band: 10–20 min** continuous before you're in the 90–110°C motor range

    - **With good airflow and metal mounts:** you may be able to run **near-continuous** at 1 kW, but you should **prove it with sensors**, not assume it

If you instead **cap each motor at ~700–800 W electrical**, the losses drop to ~80–110 W, and your steady-state rise shrinks enough that **continuous operation becomes very plausible** in this geometry.

6. Concrete takeaway for your test plan

If you want a simple operational rule of thumb for first spin-ups:

- **Full 1,000 W per motor:** Treat as **10–15 min max continuous** until you've logged real temperatures.
- **Instrument:** One thermistor/RTD on each motor can, log vs RPM and current.
- **Derated "continuous" mode:** Start with **~70–80% of rated power** as your "continuous" band and see where the temps actually land.

If you like, next step we can parameterize this so you can plug in **measured** thermal time constant and steady-state rise and regenerate the runtime curve from your own data instead of my assumed band.