

TECHNICAL REPORT

3-Inch and 3.5-Inch Open Propeller Testing

Static bench comparison of loading, efficiency, speed potential, vibration, and application fit

Test scope

16 open propellers: 13 × 3-inch and 3 × 3.5-inch

Primary data

3-3.5_ Open Props.xlsx

Supporting narrative

3-3.5 open propeller testing summary.docx

Prepared

September 14, 2026

Performance conclusions are comparative within this test cohort and test configuration.

Executive Summary

This report compares 16 open propellers in the 3-inch to 3.5-inch class using the supplied static-test workbook and narrative summary. The test series characterizes propeller loading, mechanical efficiency, vibration, rotational-speed requirement, speed potential, and mass. The purpose is not to name a universal winner; it is to show how each propeller shifts the propulsion-system trade space and to identify strong candidates for different aircraft missions.

Primary result

The EMAX Avan Mini 3X2.4X3 achieved the highest composite score (127.7) and was the strongest overall 3-inch package. It combined high thrust, low mass, strong advance ratio, and by far the lowest measured vibration at the workbook's 300 gf reference. Its efficiency was slightly below the cohort mean, so it is best described as a high-performing all-rounder rather than the efficiency leader.

Within the 3.5-inch group, the EMAX Avan Scimitar 3.5X2.8X3 produced the highest thrust at 25,000 RPM (299.7 gf), while the GemFan Hurricane 3525-3 delivered the best efficiency in the entire cohort (4.10 g/W at 300 gf) and very low vibration. The HQ T3.5X2X3 offered a gentler, efficiency-oriented alternative with lower speed potential and loading.

The 3.5-inch articles averaged 3.95 g/W at 300 gf versus 3.23 g/W for the 3-inch articles, and 253 gf at 25,000 RPM versus 147 gf. The gains come with greater mass, torque demand, packaging area, and likely larger motor requirements. Because only three 3.5-inch articles were tested, the diameter comparison is directional.

Distinction	Propeller	Measured basis
Best overall 3-inch	EMAX Avan Mini 3X2.4X3	127.7 total; exceptionally low vibration
Highest static thrust	EMAX Avan Scimitar 3.5X2.8X3	299.7 gf at 25,000 RPM
Highest efficiency	GemFan Hurricane 3525-3	4.10 g/W at 300 gf
Highest speed proxy	GemFan Flash 3052-3	Advance ratio 0.1627
Lowest mass	EMAX Avia 3X2	0.80 g
Lowest vibration	EMAX Avan Mini 3X2.4X3	0.150 at 300 gf

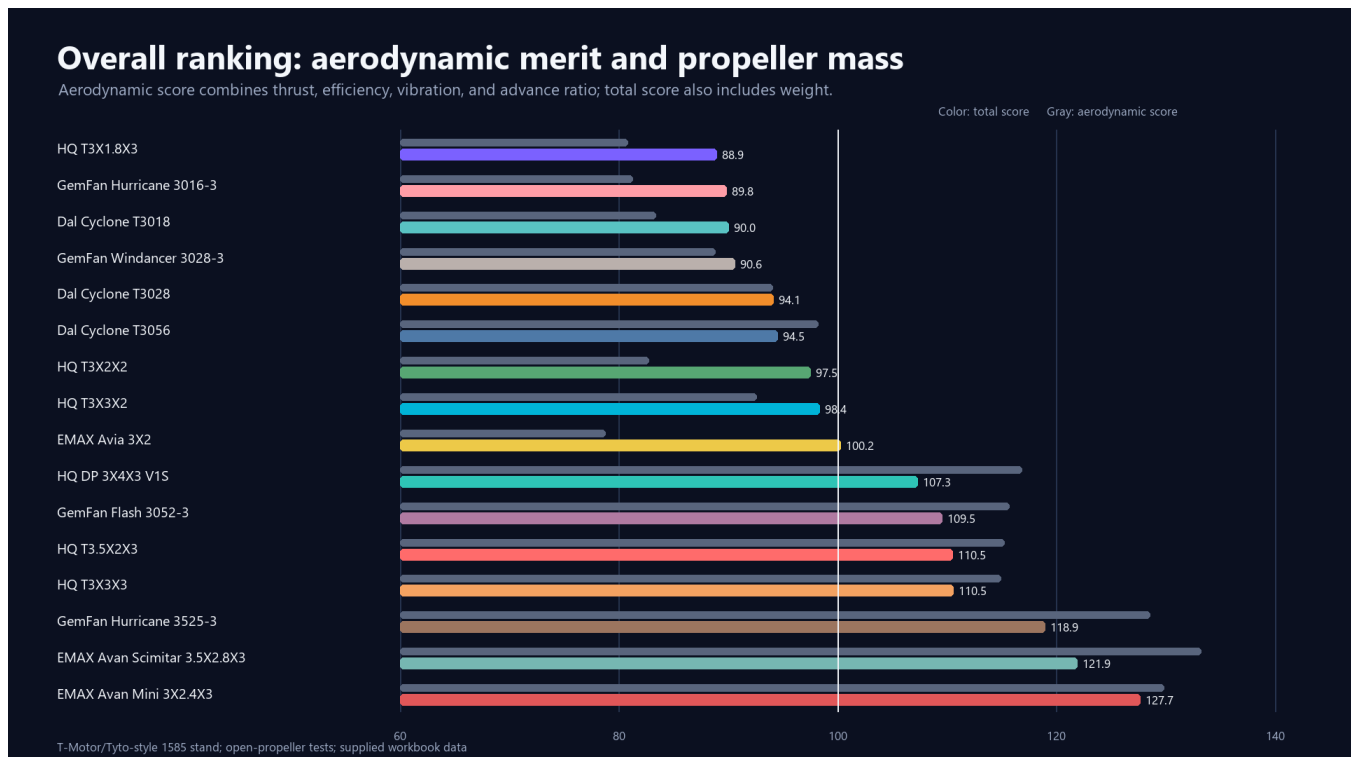


Figure 1. Overall ranking. Aerodynamic score excludes mass; total score includes it.

1. Introduction

Small multirotor propeller selection strongly affects thrust response, current and torque demand, usable flight time, top-speed potential, control smoothness, camera quality, and motor sizing. Diameter and pitch labels are only a first approximation because planform, airfoil, thickness distribution, stiffness, and manufacturing balance can materially change performance.

This program compares open propellers on a common static bench and translates the measurements into system choices. Open propellers were evaluated separately from ducted designs because narrow tips and the absence of a duct create a different aerodynamic regime. This report covers only the supplied 3-inch and 3.5-inch open-propeller dataset.

2. Objectives

- Quantify loading from thrust versus RPM and thrust at 25,000 RPM.
- Compare mechanical efficiency and vibration at a common 300 gf condition.
- Compare RPM requirement at 300 gf, advance ratio, and mass.
- Combine normalized metrics into a transparent cohort-relative score and mission shortlists.
- Identify motor-system implications, limitations, and follow-on tests.

3. Test Articles

The cohort contains thirteen 3-inch propellers and three 3.5-inch propellers. Blade count and nominal pitch are encoded in most product names; mass is from the workbook.

Propeller	Diameter (in)	Mass (g)	Total score
Dal Cyclone T3018	3.0	1.275	90.0
Dal Cyclone T3028	3.0	1.575	94.1
Dal Cyclone T3056	3.0	1.875	94.5
EMAX Avan Mini 3X2.4X3	3.0	1.250	127.7
EMAX Avia 3X2	3.0	0.800	100.2
GemFan Flash 3052-3	3.0	1.750	109.5
GemFan Hurricane 3016-3	3.0	1.200	89.8
GemFan Windancer 3028-3	3.0	1.525	90.6
HQ DP 3X4X3 V1S	3.0	2.150	107.3
HQ T3X1.8X3	3.0	1.225	88.9
HQ T3X2X2	3.0	0.950	97.5
HQ T3X3X2	3.0	1.225	98.4
HQ T3X3X3	3.0	1.600	110.5
EMAX Avan Scimitar 3.5X2.8X3	3.5	1.950	121.9
GemFan Hurricane 3525-3	3.5	1.850	118.9
HQ T3.5X2X3	3.5	1.625	110.5

4. Test Equipment and Configuration

Testing used a T-Motor/Tyto-style 1585 thrust stand in a pusher configuration to reduce downstream obstruction. Optical RPM was measured using reflective tape. Stand load cells measured axial thrust and reaction torque; voltage and current were recorded at the ESC.

A 4S battery supplied the propulsion system and was continuously supported by an external power supply to reduce voltage sag. The open-propeller articles in this report were tested on a 1504 motor. The summary indicates larger or ducted props elsewhere in the program used 2004/2005-class motors; those are outside this report.

Comparison basis

Electrical input power includes motor, ESC, and wiring losses and is motor-dependent. This report therefore emphasizes mechanical shaft power (reaction torque × angular velocity) and RPM when comparing propeller aerodynamics.

5. Test Methodology

5.1 Static sweep and measured channels

Each propeller was mounted in the same stand configuration and swept through a usable operating range. Synchronized data produced thrust–RPM, efficiency–thrust, and vibration–thrust curves. The workbook supplies common reference-point values for direct comparison.

5.2 Mechanical power and efficiency

Mechanical shaft power was calculated from measured reaction torque and optical speed:

$$P_m = \tau\omega = \tau(2\pi N/60)$$

P_m is mechanical power, τ is reaction torque, ω is angular speed, and N is RPM. Efficiency is grams-force of thrust per mechanical watt at 300 gf; higher values indicate more thrust per unit shaft power.

5.3 Common comparison points

Metric	Reference	Interpretation
Thrust	25,000 RPM	Loading at equal speed; higher requires more torque.
Efficiency	300 gf	Thrust per mechanical watt.
Vibration	300 gf in workbook	Lower indicates smoother response.
RPM requirement	300 gf	Lower RPM indicates greater loading.
Advance ratio	Calculated	Relative speed-potential proxy.
Mass	Measured	Rotating and aircraft mass contribution.

Traceability note — vibration reference

The narrative describes vibration near 200 g thrust, while workbook headers, scores, and plotted reference values specify 300 gf. The workbook is the numerical source of record, so this report uses 300 gf and flags the mismatch as a documentation limitation.

5.4 Normalized scoring

The workbook normalizes each category to the cohort average, where approximately 100 is average. Higher measured thrust, efficiency, and advance ratio score higher; lower mass and vibration score higher. Total Score is the unweighted mean of the five category scores. It is therefore a balanced comparison, not a universal mission optimum.

6. Results Overview

No propeller dominates every dimension. The strongest articles occupy different regions: light low-load props, high-loading speed props, efficient 3.5-inch props, and smooth video-oriented props. Scores are relative to this cohort and are not absolute quality grades.

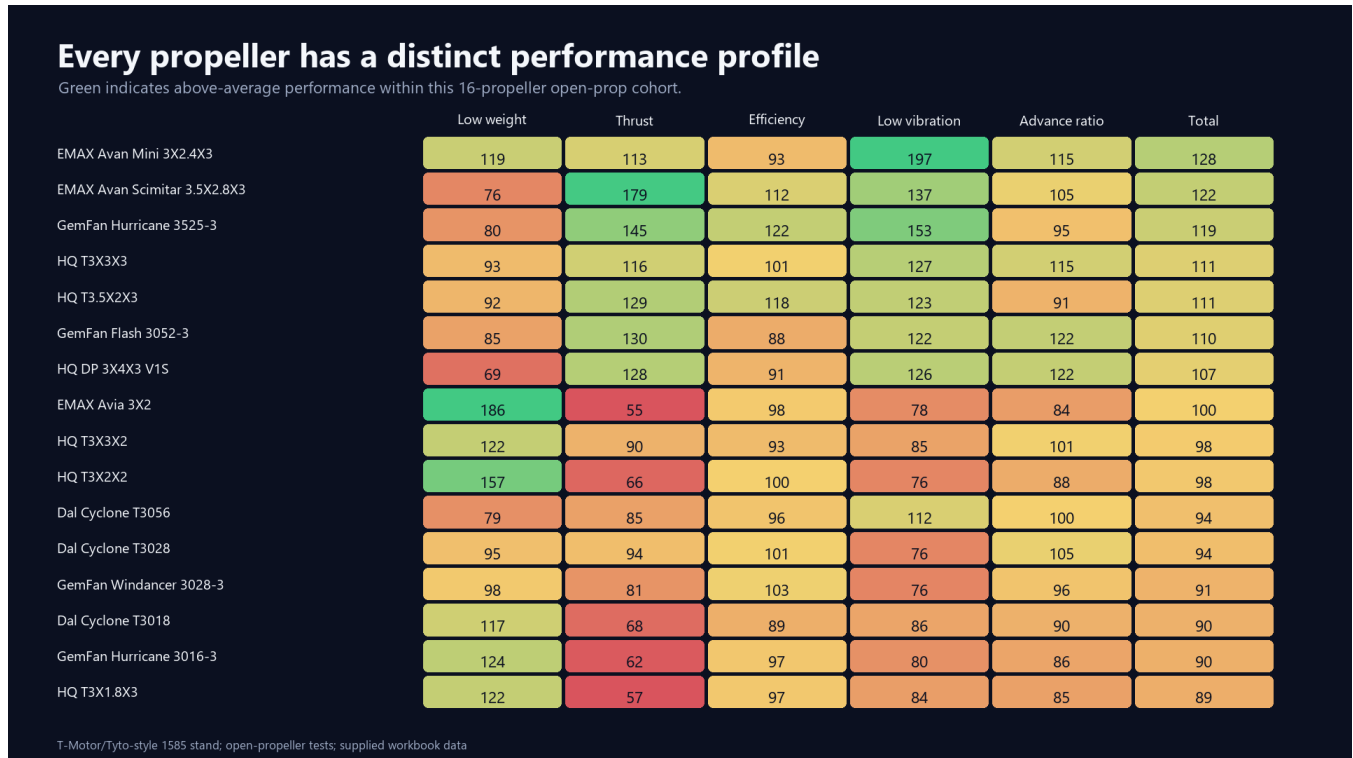


Figure 2. Normalized scorecard. Values above 100 are better than the cohort average.

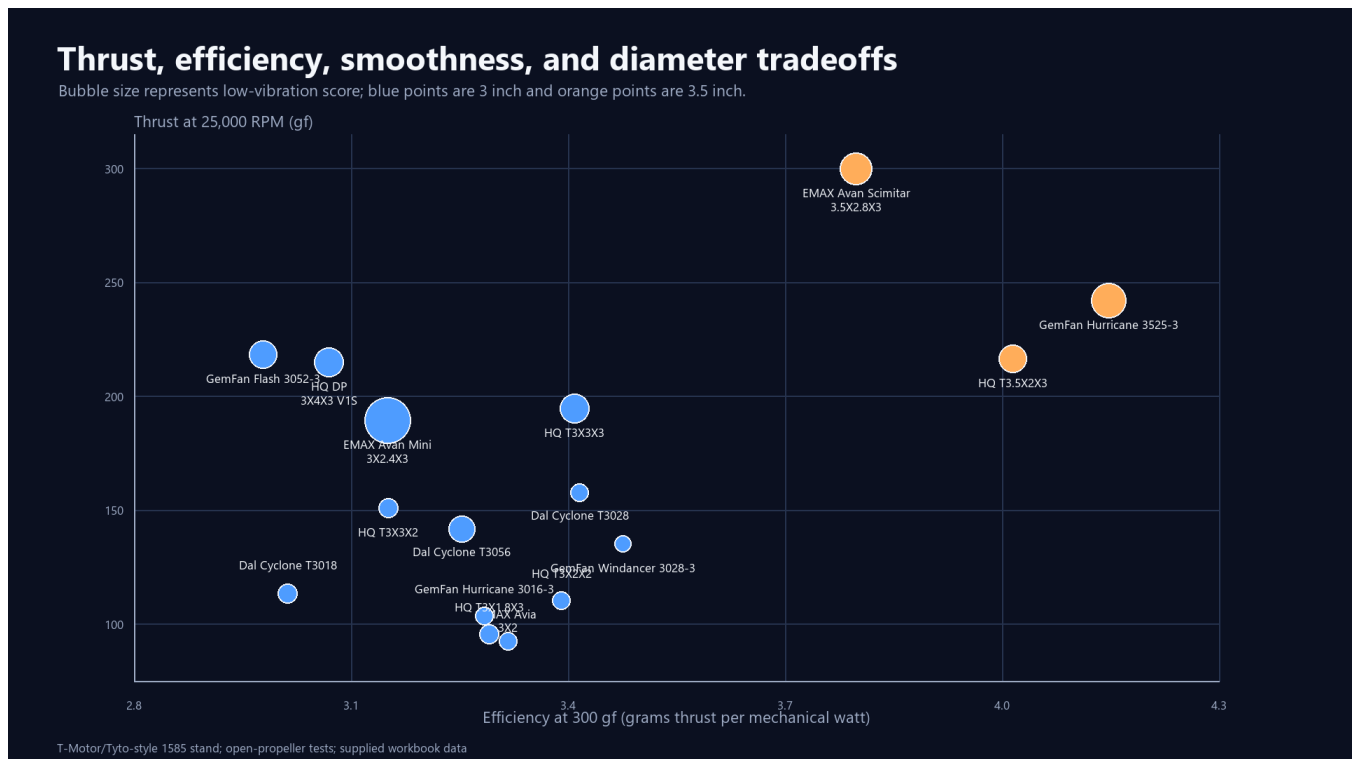


Figure 3. Thrust–efficiency trade space. Bubble area reflects the low-vibration score.

7. Propeller Loading and Thrust

Thrust at common RPM indicates aerodynamic loading. The cohort spans 92.4 to 299.7 gf at 25,000 RPM, more than a threefold range. High-loading props can make strong thrust without extreme RPM but demand more motor torque, current, and thermal margin. Low-loading props offer softer response and are easier for small motors to turn, but may reach RPM limits before meeting thrust requirements.

The EMAX Avan Scimitar led at 299.7 gf, followed by the GemFan Hurricane 3525-3 at 242.0 gf. Among 3-inch props, the GemFan Flash 3052-3 led at 218.1 gf, just ahead of the HQ DP 3X4X3 V1S at 214.8 gf. The EMAX Avia 3X2 was lightest-loaded at 92.4 gf.



Figure 4. Thrust versus rotational speed. All panels use a common thrust scale.

8. Mechanical Efficiency and Diameter Effects

The GemFan Hurricane 3525-3 led efficiency at 4.10 g/W at 300 gf, followed by the HQ T3.5X2X3 at 3.97 and the EMAX Avan Scimitar at 3.77. The best 3-inch value was the GemFan Windancer 3028-3 at 3.45 g/W, closely followed by the Dal Cyclone T3028 and HQ T3X3X3.

The 3.5-inch group averaged 22% higher efficiency and 72% greater thrust at 25,000 RPM than the 3-inch group. The larger disk moves more air but costs frame clearance, inertia, mass, and torque demand.

Efficiency across the useful thrust range

Higher curves produce more thrust from each watt of mechanical shaft power.

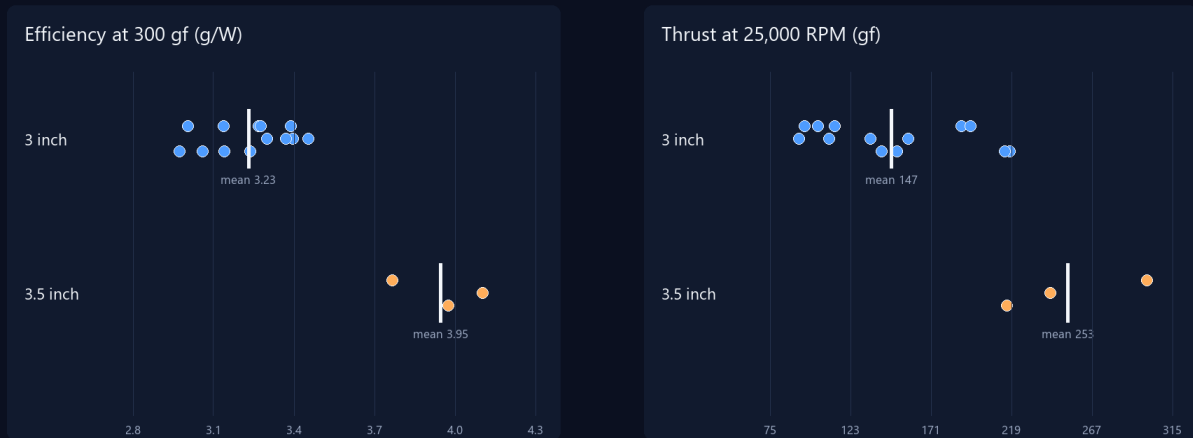


Efficiency-versus-thrust curves; mechanical-power basis

Figure 5. Mechanical efficiency across thrust. Higher curves indicate more thrust per shaft watt.

Propeller diameter changes efficiency and loading

Dots show individual props; horizontal bars show the mean for each diameter group.



T-Motor/Tyto-style 1585 stand; open-propeller tests; supplied workbook data

Figure 6. Distribution and mean performance by diameter; groups are unequal ($n=13$ and $n=3$).

9. Advance Ratio and Speed Potential

The highest advance ratios belonged to the GemFan Flash 3052-3 (0.1627) and HQ DP 3X4X3 V1S (0.1620), followed by the EMAX Avan Mini and HQ T3X3X3 near 0.1535. These are strong speed candidates. Static advance ratio does not capture airframe drag, voltage headroom, dynamic inflow, or blade unloading; flight validation is required.

10. Vibration and Smoothness

Vibration affects video, inertial sensors, controller filtering, bearings, and post-processing. The EMAX Avan Mini produced the lowest workbook value at 300 gf (0.150), well below the GemFan Hurricane 3525-3 (0.195) and EMAX Avan Scimitar (0.216). The GemFan Windancer 3028-3 and Dal Cyclone T3028 were highest near 0.392 and 0.390.

Curve shape matters because resonant peaks can occur away from 300 gf and coincide with hover or cruise. Airframe validation should cover the intended throttle range.

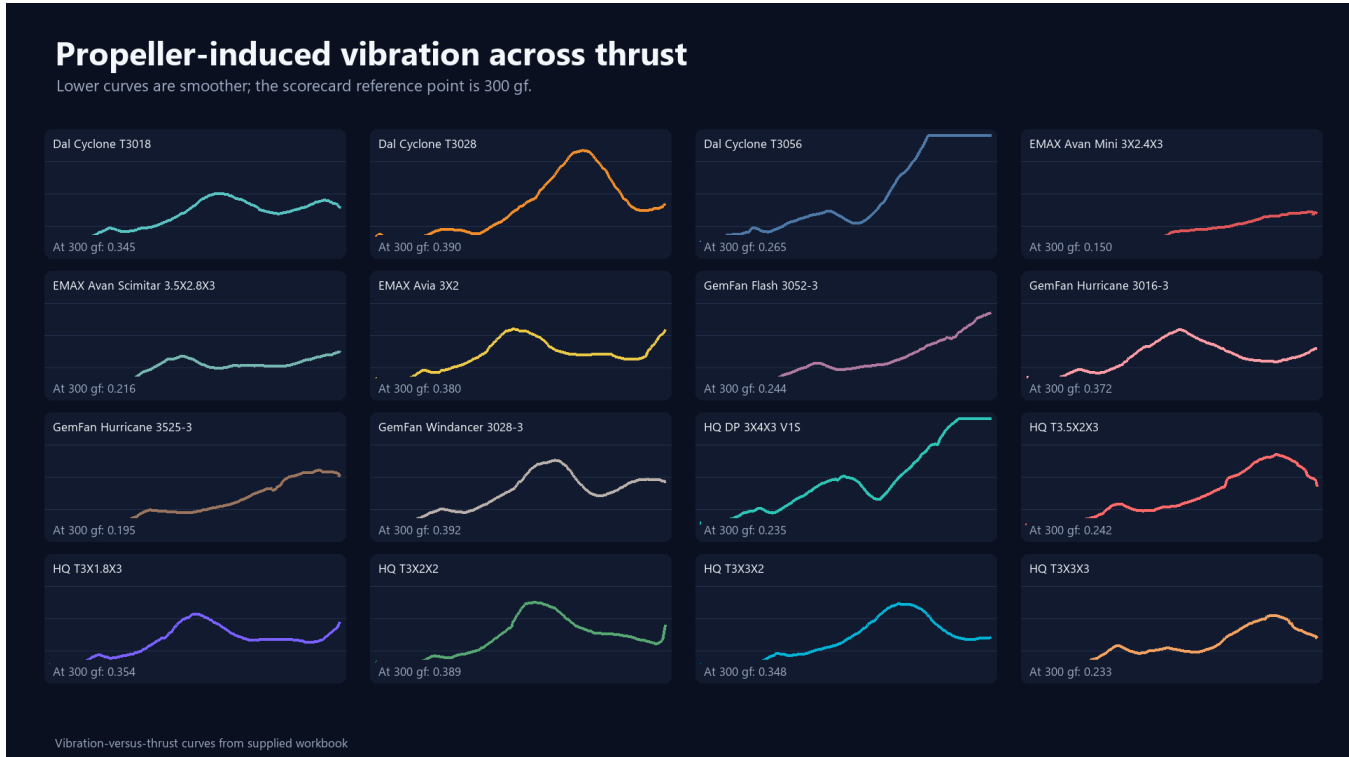


Figure 7. Vibration across thrust. Lower is preferable; values above the display ceiling are clipped at the panel top.

11. Mass and Motor-System Implications

Mass ranged from 0.80 g for the EMAX Avia 3X2 to 2.15 g for the HQ DP 3X4X3 V1S. Lower rotating mass can improve spool response and reduce aircraft mass; higher mass increases inertia and crash loads. Aerodynamic loading governs steady torque while inertia affects transients.

The summary treats light 3-inch props as candidates for 1204/1303-class motors and suggests 1504/1505-class motors for heavily loaded 3-inch and 3.5-inch options. These are starting points, not validated limits. Final selection must confirm current, motor and ESC temperature, shaft and bearing durability, and battery sag.

12. Application-Oriented Selection

Mission indices were derived from the five measured category scores. Long-range weighting emphasizes efficiency and low mass; freestyle balances all attributes; racing emphasizes advance ratio and thrust; video emphasizes low vibration. These are decision aids, not new measurements.

Different missions produce different propeller shortlists

Derived indices apply explicit weights to measured category scores; they are decision aids, not new measurements.

	Long-range	Freestyle	Racing / speed	Video / smoothness
EMAX Avan Mini 3X2.4X3	118	127	117	147
EMAX Avan Scimitar 3.5X2.8X3	113	127	129	124
GemFan Hurricane 3525-3	117	122	116	130
HQ T3.5X2X3	112	112	109	116
GemFan Flash 3052-3	98	112	116	109
HQ T3X3X3	105	112	111	114
HQ DP 3X4X3 V1S	96	110	113	109
HQ T3X3X2	99	97	99	94
Dal Cyclone T3056	93	95	92	100
Dal Cyclone T3028	95	94	98	88
EMAX Avia 3X2	112	94	90	97
HQ T3X2X2	107	93	91	94
GemFan Windancer 3028-3	95	90	91	87
Dal Cyclone T3018	94	88	86	90
GemFan Hurricane 3016-3	97	87	84	89
HQ T3X1.8X3	97	86	82	90

Long-range emphasizes efficiency and weight; racing emphasizes advance ratio and thrust; video emphasizes low vibration

Figure 8. Derived mission-fit indices. Validate finalists on the intended motor and airframe.

Mission	Top three derived candidates
Long-range	EMAX Avan Mini 3X2.4X3 (118); GemFan Hurricane 3525-3 (117); EMAX Avan Scimitar 3.5X2.8X3 (113)
Freestyle	EMAX Avan Mini 3X2.4X3 (127); EMAX Avan Scimitar 3.5X2.8X3 (127); GemFan Hurricane 3525-3 (122)
Racing / speed	EMAX Avan Scimitar 3.5X2.8X3 (129); EMAX Avan Mini 3X2.4X3 (117); GemFan Flash 3052-3 (116)
Video / smoothness	EMAX Avan Mini 3X2.4X3 (147); GemFan Hurricane 3525-3 (130); EMAX Avan Scimitar 3.5X2.8X3 (124)

13. Propeller-by-Propeller Conclusions

EMAX Avan Mini 3X2.4X3. Best overall 3-inch result: strong thrust, low mass, strong advance ratio, and exceptional smoothness. Efficiency is slightly below average, but the profile is compelling for freestyle, racing, and video builds.

EMAX Avan Scimitar 3.5X2.8X3. Highest-thrust article and strongest aggressive 3.5-inch choice. Good efficiency and low vibration accompany high loading; validate motor, ESC, and thermal margin.

GemFan Hurricane 3525-3. Efficiency leader and smooth balanced 3.5-inch option. It gives up speed proxy to the Scimitar but is preferred for efficient cruise, long-range, or video.

HQ T3X3X3. Strong all-around 3-inch alternative with above-average thrust, efficiency, smoothness, and speed potential, though heavier and less smooth than the Avan Mini.

HQ T3.5X2X3. Efficient, comparatively light 3.5-inch alternative with moderate loading and good smoothness. Lower advance ratio favors controlled efficiency over maximum speed.

GemFan Flash 3052-3. Fast, highly loaded 3-inch option with the highest advance ratio. Below-average efficiency and higher mass make it best for speed builds with adequate torque.

HQ DP 3X4X3 V1S. Aggressive speed prop with high thrust and advance ratio. It is the heaviest article and has below-average efficiency, requiring a robust powertrain.

EMAX Avia 3X2. Lightest and very low-load. Suitable for ultralight aircraft and small motors, but low thrust, low speed proxy, and high vibration limit aggressive and video use.

HQ T3X3X2. Light two-blade with moderate thrust and speed potential. Efficiency and smoothness trail the leading all-rounders.

HQ T3X2X2. Very light and reasonably efficient, but lightly loaded and among the least smooth. Candidate for ultralight low-torque systems, not peak thrust or pristine video.

Dal Cyclone T3056. Relatively smooth but heavy for its moderate thrust. A niche option rather than a leading balanced or speed choice.

Dal Cyclone T3028. Moderate thrust, efficiency, and speed potential. High measured vibration and middling mass reduce video suitability.

GemFan Windancer 3028-3. Best 3-inch efficiency but modest thrust and the highest vibration. Worth endurance experiments if the airframe avoids or isolates its vibration behavior.

Dal Cyclone T3018. Lightly loaded and modest-speed with below-average efficiency and smoothness. Useful for low-power training or constrained motors.

GemFan Hurricane 3016-3. Light, low-load with near-average efficiency but low thrust, speed proxy, and smoothness. Favors easy motor loading over lift or speed.

HQ T3X1.8X3. Low-load, low-speed option with modest efficiency. Light mass is useful, but thrust and overall score are lowest; choose when motor demand must remain low.

14. Limitations and Uncertainty

- Static-stand results do not reproduce forward-flight inflow, body blockage, maneuvers, or propeller–airframe interaction.
- The sources do not provide repeat count, uncertainty bands, load-cell accuracy, calibration records, environmental conditions, or specimen variation; statistical significance cannot be established.
- The vibration reference differs between sources: approximately 200 g in the narrative versus 300 gf in workbook headers and scores.
- All open props used one 1504 motor. Mechanical-power normalization reduces but does not eliminate motor, controller, bearing, fixture, and range interactions.
- The 3.5-inch group has only three props versus thirteen 3-inch props; group means describe these samples only.
- Pusher mounting reduces downstream obstruction but may not duplicate tractor operation.
- The supported 4S source reduces sag, but field batteries may produce different voltage, current, and temperature behavior.
- Advance ratio is a proxy; top speed must be measured in flight.
- Durability, noise, stiffness, crash resistance, price, balance, and manufacturing consistency were not scored.

15. Recommended Follow-On Testing

- Test at least three specimens per model with repeated runs; report mean, dispersion, confidence intervals, and calibration uncertainty.
- Resolve the vibration reference and document sensor, axis, bandwidth, sample rate, and processing.
- Map current and motor/ESC temperature on candidate 1204/1303 and 1504/1505 systems.
- Quantify tractor-versus-pusher and stand-blockage effects.
- Flight-test hover efficiency, speed, acceleration, temperatures, gyro noise, and video quality.
- Evaluate durability, noise, stiffness, dynamic balance, and lot-to-lot variation.
- Reweight the mission model using actual aircraft requirements, minimum thrust margin, and current limits.

16. Final Conclusions

Propeller selection is a system trade, not a single-variable optimization. In this cohort, 3.5-inch props substantially increased thrust and mechanical efficiency but also increased load, mass, and integration demands. Geometry created a wide spread even among nominally 3-inch props.

For a broadly capable 3-inch aircraft, the EMAX Avan Mini 3X2.4X3 is the leading starting point. For maximum 3.5-inch thrust, select the EMAX Avan Scimitar 3.5X2.8X3 for validation. For 3.5-inch efficiency and smoothness, the GemFan Hurricane 3525-3 is preferred. For 3-inch speed, the GemFan Flash 3052-3 and HQ DP 3X4X3 V1S merit testing, with penalties in efficiency and/or mass.

These conclusions form a rigorous static-data shortlist. Final selection must confirm motor thermal margin, current, flight behavior, vibration on the intended airframe, and manufacturing consistency.

Selection need	Recommended starting point	Reason
Balanced 3-inch	EMAX Avan Mini 3X2.4X3	Best composite result; extremely smooth
Maximum 3.5-inch thrust	EMAX Avan Scimitar 3.5X2.8X3	Highest thrust at common RPM
Efficient 3.5-inch	GemFan Hurricane 3525-3	Highest mechanical efficiency; low vibration
Speed-focused 3-inch	GemFan Flash 3052-3 / HQ DP 3X4X3 V1S	Highest advance-ratio results
Lowest motor load	EMAX Avia 3X2	Lowest mass and lowest loading

Appendix A — Primary Results

Propeller	Dia. (in)	Mass (g)	Thrust @ 25k (gf)	Efficiency @ 300 gf	Vibration @ 300 gf	RPM @ 300 gf	Advance ratio	Total
EMAX Avan Mini 3X2.4X3	3.0	1.250	189.3	3.139	0.150	30,882	0.1537	127.7
EMAX Avan Scimitar 3.5X2.8X3	3.5	1.950	299.7	3.765	0.216	25,013	0.1394	121.9
GemFan Hurricane 3525-3	3.5	1.850	242.0	4.102	0.195	27,593	0.1264	118.9
HQ T3X3X3	3.0	1.600	194.4	3.389	0.233	30,909	0.1535	110.5
HQ T3.5X2X3	3.5	1.625	216.5	3.975	0.242	28,888	0.1207	110.5
GemFan Flash 3052-3	3.0	1.750	218.1	2.972	0.244	29,163	0.1627	109.5
HQ DP 3X4X3 V1S	3.0	2.150	214.8	3.061	0.235	29,290	0.1620	107.3
EMAX Avia 3X2	3.0	0.800	92.4	3.300	0.380	42,607	0.1114	100.2
HQ T3X3X2	3.0	1.225	150.9	3.140	0.348	35,136	0.1351	98.4
HQ T3X2X2	3.0	0.950	110.4	3.371	0.389	40,339	0.1176	97.5
Dal Cyclone T3056	3.0	1.875	141.7	3.238	0.265	35,646	0.1331	94.5
Dal Cyclone T3028	3.0	1.575	157.5	3.395	0.390	33,983	0.1397	94.1
GemFan Windancer 3028-3	3.0	1.525	135.0	3.454	0.392	37,053	0.1281	90.6
Dal Cyclone T3018	3.0	1.275	113.4	3.006	0.345	39,560	0.1200	90.0
GemFan Hurricane 3016-3	3.0	1.200	103.5	3.268	0.372	41,296	0.1149	89.8
HQ T3X1.8X3	3.0	1.225	95.5	3.275	0.354	41,932	0.1132	88.9

Source: supplied workbook, scores sheet. Values are rounded for reporting; calculations use stored values.

Appendix B — Normalized Scores

Propeller	Low mass	Thrust	Efficiency	Low vibration	Advance ratio	Aero.	Total
EMAX Avan Mini 3X2.4X3	119.1	113.2	93.3	197.4	115.4	129.8	127.7
EMAX Avan Scimitar 3.5X2.8X3	76.4	179.2	111.9	137.2	104.6	133.2	121.9
GemFan Hurricane 3525-3	80.5	144.7	121.9	152.6	94.9	128.5	118.9
HQ T3X3X3	93.1	116.3	100.7	127.4	115.3	114.9	110.5
HQ T3.5X2X3	91.6	129.5	118.1	122.7	90.6	115.2	110.5
GemFan Flash 3052-3	85.1	130.5	88.3	121.7	122.2	115.7	109.5
HQ DP 3X4X3 V1S	69.3	128.5	90.9	126.2	121.6	116.8	107.3
EMAX Avia 3X2	186.1	55.3	98.0	78.2	83.6	78.8	100.2
HQ T3X3X2	121.6	90.2	93.3	85.3	101.4	92.6	98.4
HQ T3X2X2	156.7	66.0	100.2	76.3	88.3	82.7	97.5
Dal Cyclone T3056	79.4	84.7	96.2	112.1	99.9	98.2	94.5
Dal Cyclone T3028	94.5	94.2	100.9	76.2	104.8	94.0	94.1
GemFan Windancer 3028-3	97.6	80.8	102.6	75.8	96.1	88.8	90.6
Dal Cyclone T3018	116.8	67.8	89.3	86.1	90.1	83.3	90.0
GemFan Hurricane 3016-3	124.1	61.9	97.1	79.7	86.3	81.2	89.8
HQ T3X1.8X3	121.6	57.1	97.3	83.8	85.0	80.8	88.9

Approximately 100 is cohort average. Aerodynamic score excludes mass and is added here for interpretation; Total is the workbook mean of all five categories.

Appendix C — Data and Figure Traceability

Information	Source	Use
Narrative and apparatus	3-3.5 open propeller testing summary.docx	Introduction, configuration, methodology
Primary metrics and scores	3-3.5_ Open Props.xlsx — scores	Tables, rankings, conclusions
Thrust-RPM curves	3-3.5_ Open Props.xlsx — thrust_rpm	Figure 4
Efficiency-thrust curves	3-3.5_ Open Props.xlsx — eff_thrust	Figure 5
Vibration-thrust curves	3-3.5_ Open Props.xlsx — vib_thrust	Figure 7
Mission indices	Derived from workbook scores	Figure 8 and shortlist