Raven Perch

Raven Perch 0.2.0 is the twin-tractor flying-wing tail-sitter with a removable nose and four-point landing cradle. Module-local rail stocks preserve the nose and cradle release paths. The hatch opens before access to either hook and cam. Check retention and loads on the exact physical bench article.



Assembled view from the revision-matched CAD.

In this guide

01 Print and measure the P1S fit coupons

02 Dry-fit the nose and landing cradle

03 Open the hatch and service both snap joints

04 Fit the wing panels and elevons

05 Install the motors and protected power harness

06 Mount the controller, receiver and sensors

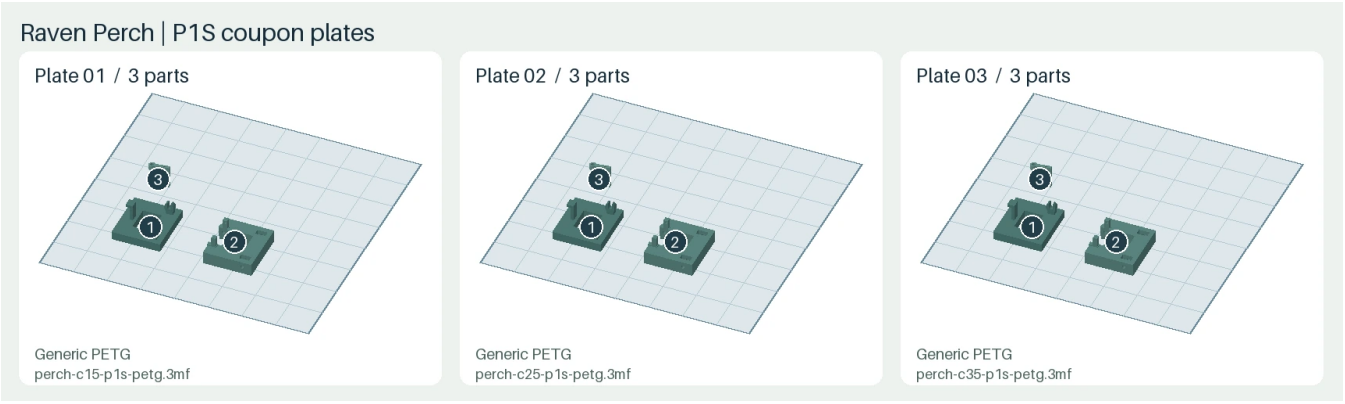
07 Check radio and controls with the propellers removed

08 Measure installed fit, mass and propulsion

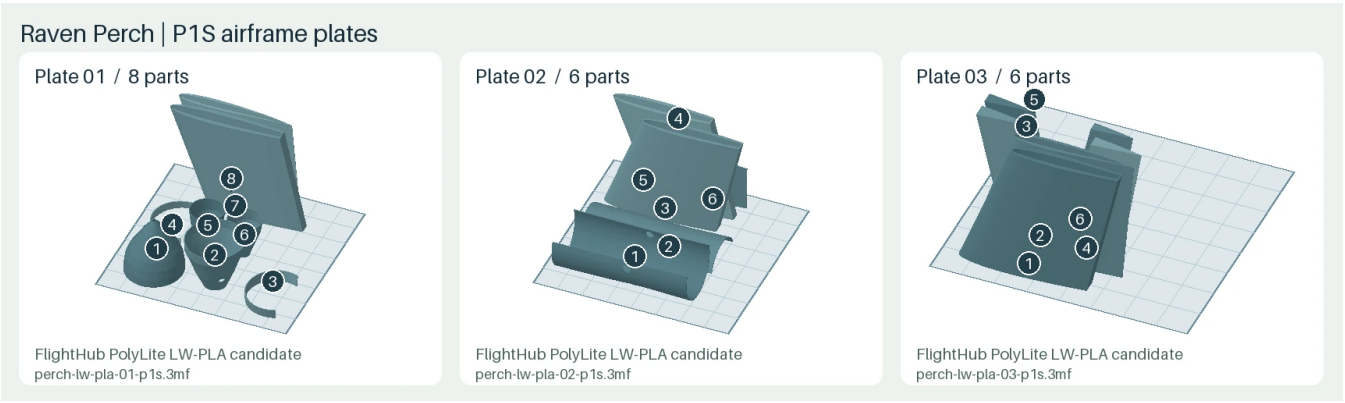
09 Review the hover and transition gates

Print setup

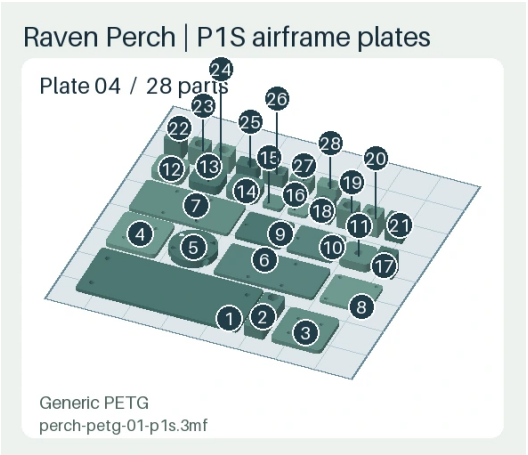
Bambu Lab P1S with a 0.4 mm nozzle. Start with the saved 0.15, 0.25 and 0.35 mm clearance coupon projects. The coupon profiles use Generic PETG on textured PEI at 0.20 mm layers, four walls and 30% gyroid. The 4 editable airframe plates were checked with Bambu Studio 02.09.01.70. Verify material, bed, supports and orientation on your own printer. Record the physical print, fit, retention, mass and balance before applying power.



Raven Perch coupon plates 01-03. Saved print orientations on the P1S bed.



Raven Perch airframe plates 01-03. Saved print orientations on the P1S bed.



Raven Perch airframe plate 04. Saved print orientations on the P1S bed.

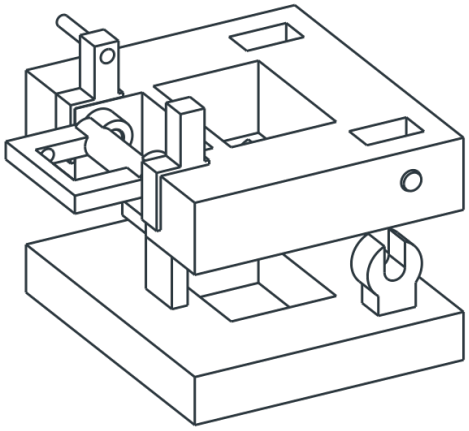
01 Print and measure the P1S fit coupons

Why this matters

The hook and cam need repeatable shoulder seating while the positive catch remains independently accessible.

Where to look

Match each hook and receiver pair on the P1S coupon sheets. Inspect cam and catch orientation before checking fit.



Inherited coupon solids with identical installed source links. This is a fit sample.

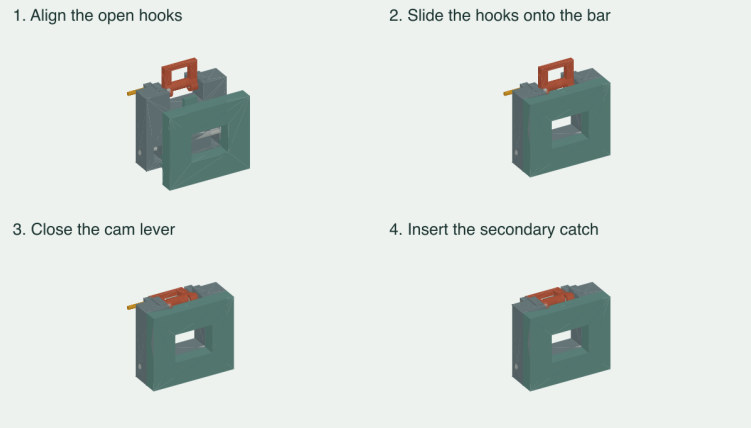
1. Start with the 0.15, 0.25 and 0.35 mm Perch clearance variants. Print each mating set on the P1S with the 0.4 mm nozzle and record material lot, orientation and profile.

2. With the lever open, seat both hooks over the bar. Close the lever and insert the independent catch. Look for full contact at the stops and a visible, deliberately releasable catch.

3. Record insertion and release effort, seam gap, rocking and retention. Repeat on specimens after assembly cycles and a reviewed thermal and vibration exposure. Carry the selected profile and clearance to the installed interfaces.

Before you continue

Record catch engagement, insertion and withdrawal effort, seam gap, play and wear for each tested clearance.



Use the isolated coupon to check the latch sequence before trying it on the full airframe.

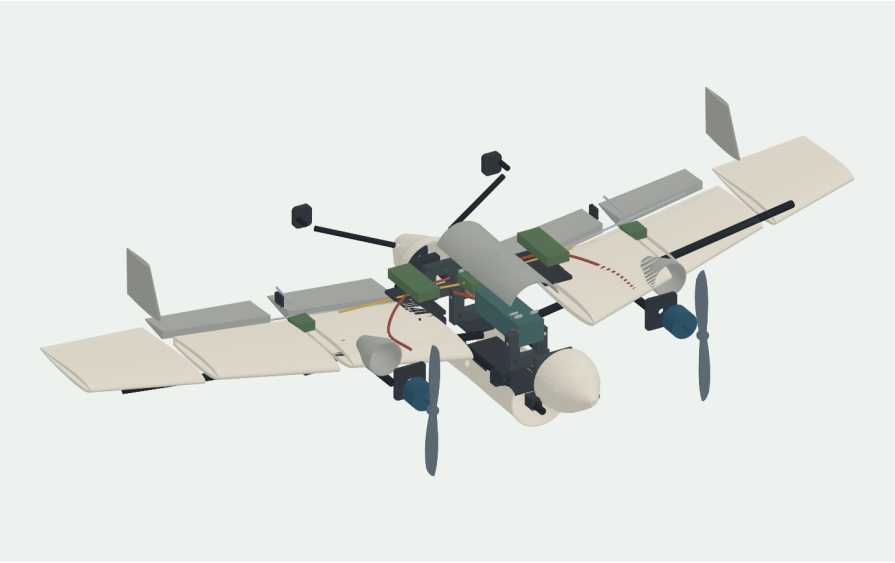
02 Dry-fit the nose and landing cradle

Why this matters

Module-local rails keep each release path clear while the aft hub takes the landing loads.

Where to look

Check each rail and shoe inside its own module. Trace the landing struts through the shell clearance ports into the cradle hub.



Exact 0.2.0 scene meshes with service parts separated for identification.

1. Fit the inherited c25 hook bar, cam pivots and positive catch with the exact coupon before installing the interface. Compare actual insertion and release effort.

2. Fit the nose, center and cradle rail stocks to their own module-local shoes. Dry-fit the revised aft bridge and hub with both mounting bolts and confirm no stock extends across either opening path.

3. Check the relocated receiver envelope at X238 and Z18 mm before trying the aft cam. Restrain the actual harness clear of that sweep. Keep the shortened avionics deck ahead of the aft receiver and check the two Ø10.2 mm shell clearance ports around the Ø9 mm wing spars.

4. Trial-fit each actual carbon strut into its angled landing-stock pocket. Check that the stock clears its cosmetic aft shell port so the hub carries the landing loads.

5. Check the hatch removal route with the battery disconnected. Confirm the actual rail, fastener, bridge and hinge load path before physical commissioning.

Before you continue

Check both actual spar clearances, receiver clearance, rail retention and all four stock-to-hub interfaces.

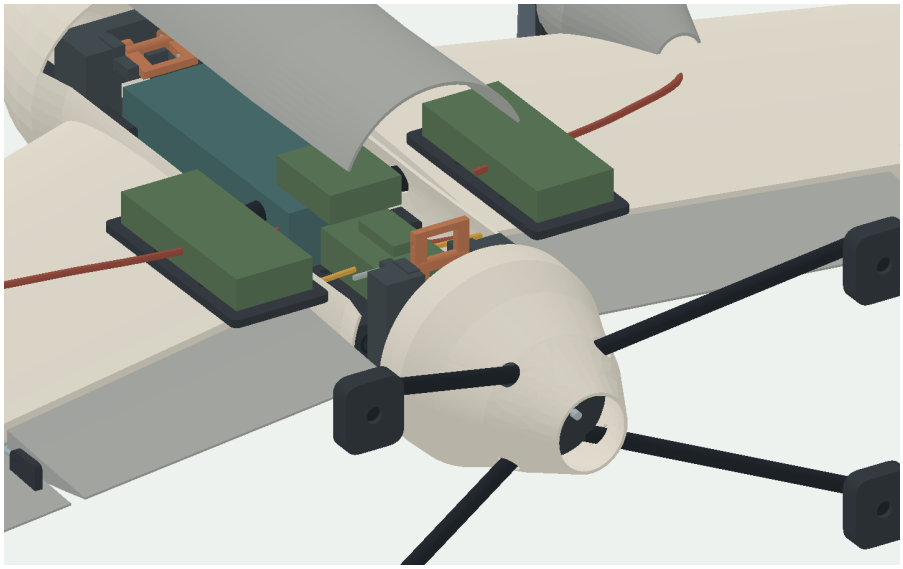
03 Open the hatch and service both snap joints

Why this matters

The center hatch opens access to the catches, cams and detachable end modules.

Where to look

Select Installed joint service. The same raised-hatch setup applies to the nose and aft sequences.



Exact successor service-review scene at the aft withdrawal pose. Physical clearance and retention still need measurement.

1. Remove the propellers and isolate the battery. Lift the center service hatch along the nominal +Z CAD path to its 48 mm access pose. Disconnect and restrain any module leads that cross the interface before removing either catch.

2. At the nose, withdraw the positive catch 11 mm sideways, open the cam through the modeled 98° range and withdraw the complete keyed nose assembly 18 mm along the forward axis. Stop at resistance. Keep its two rails in the nose.

3. At the rear, withdraw the positive catch 11 mm, swing the cam 98° and withdraw the complete four-point landing cradle 18 mm along the aft axis. The aft bridge bolts and spacers stay with the cradle. Verify all four pad and strut attachments.

4. Reassemble in reverse order. Seat the shoulders, confirm both hooks are engaged, close each cam and reinstall each independent catch before closing the hatch. Review wear, loaded play and landing loads before any powered trial.

Before you continue

Verify hook seating, catch retention and each module’s actual withdrawal path with the leads disconnected and secured.

04 Fit the wing panels and elevons

Why this matters

Matching wing alignment and retained elevons support predictable control response and landing clearance.

Where to look

Follow the main spar through the center shell and locate the servo leads behind the motor mounts.

1. Dry-fit the nominal 9 mm outer diameter carbon main spar and the root restraints, then fit the port and starboard panels. Check matching twist and alignment and inspect each spar seat.

2. Fit retained elevon hinges, horns and linkages. Check the full mechanism sweep in both aircraft orientations. Leave control throws and trim open for review.

3. Confirm each elevon sits behind its motor disc and has clearance to the cradle and the work surface throughout the expected travel. Keep servo leads clear of hinges and seams.

Before you continue

Record wing alignment, hinge retention and free elevon travel with clearance to the cradle and work surface.

05 Install the motors and protected power harness

Why this matters

A secure installation keeps both tractor motor branches accessible and away from the latches and propeller discs.

Where to look

Use the motor plate mounting patterns, the separate ESC mounts and the central pack restraint.

1. Fit both EMAX ECO II 2807 1700KV motors to measured 19 × 19 mm M3 mounting patterns. Confirm safe screw depth and secured wiring. Leave the propellers off.

2. Fit both Hobbywing Skywalker 60A V2 ESCs with ventilation and strain relief. Connect three motor phase wires on each side. Depin and insulate both ESC BEC positive leads. Keep their signal grounds.

3. Fit the Tattu 4S pack with a structural strap and axial restraint. Verify connector access, fuse and disconnect locations, and motor-branch current capacity before the first powered run.

Before you continue

Check screw depth, cooling, battery restraint and motor-branch protection with both propellers removed.

06 Mount the controller, receiver and sensors

Why this matters

The relocated receiver needs clearance to the aft cam while the controller and sensors remain accessible.

Where to look

Look above the shortened avionics deck and identify the aft receiver, wiring corridor and controller orientation.



Revision-matched worksheet. Check exact pinouts and confirm the hardware with propellers removed.

1. Mount the SpeedyBee F405 Wing Mini in its forward-flight orientation. Route the USB and microSD access so that the nose can remain locked during checks.

2. S1 Port throttle (PWM, function 73) · S2 Starboard throttle (PWM, function 74) · S3 Port elevon (PWM, function 77)

3. S4 Starboard elevon (PWM, function 78)

4. Use UART1 for CRSF and UART3 for GNSS, with the compass on I²C. Verify pin order, cross UART transmit and receive, and power both peripherals from the independent verified 5 V regulator with a common ground.

Before you continue

Verify terminal assignments, supply isolation, service access and actual harness clearance throughout the cam sweep.

07 Check radio and controls with the propellers removed

Why this matters

Control checks establish the correct outputs and loss-of-link behavior in the intended ground modes.

Where to look

Use the installed controller map for both ESC channels and both elevons, then verify the receiver connection.

1. Check polarity, regulator isolation and loaded rail voltage using a current-limited source. Calibrate the controller and ESC endpoints using the exact firmware and component instructions.

2. Verify left and right motor output, each motor's direction and both elevon correction directions in forward-flight and nose-up orientations. Check the linkages under load for binding, flex and voltage drop.

3. Check throttle cut, receiver range, loss of link, arm/disarm behavior and the approved ground-mode setup. Record observed failsafe results and keep a parameter export with the bench notes.

Before you continue

Record measured rail voltage, control directions, throttle cut, range and failsafe with the propellers off.

08 Measure installed fit, mass and propulsion

Why this matters

A fit and balance record links any propulsion result to the exact built airframe and its landing cradle.

Where to look

Measure the complete article with its secured pack, both motors, control linkages, latches and four cradle feet installed.

1. Record total assembled mass, actual battery position, hardware and profile IDs, mounted propeller clearance, fastener retention and the measured balance datum. Keep the allowable CG and throws open until reviewed.

2. With a rated guarded fixture and remote cutoff, test one exact motor and 7042-2 propeller first. Review single-branch results before operating both motors together. Log thrust, current, voltage sag, RPM, temperature and movement.

3. Use the lowest reviewed safe electrical limit and a provisional 25 A aggregate abort ceiling for the first controlled paired trial. Inspect latches, wiring and hardpoints after the run. Measure elevon control authority in the propeller airflow before requesting hover review.

Before you continue

Record actual mass, balance, current and retention. Review measured control behavior before planning hover.

09 Review the hover and transition gates

Why this matters

Nose-up and wing-borne tests need separate measured limits for the same configuration.

Where to look

Review touchdown stability, propeller and elevon clearance, and throttle behavior in the bench configuration.

1. Review the exact measured mass, CG range, linkage loads, landing restraint and usable thrust margin. Verify actuator and sensor behavior with the actual power and firmware configuration.

2. Treat Flightory Riflebird as a precedent for fixed thrust and elevons in the propeller airflow. Perch requires its own CG, thrust and transition evidence.

3. A separate supervised test plan covers takeoff, nose-up hover, vertical landing and both directions of transition. Record limitations and abort behavior. Carry forward measured outcomes only for the documented configuration.

Before you continue

Use a separately reviewed plan for vertical takeoff, landing and both transition directions after completing the bench evidence.

Wiring worksheet

SpeedyBee F405 WING MINI

Port and starboard are defined looking forward from behind the aircraft in its forward-flight orientation.

Use PWM signal and ground for both ESCs. Isolate both ESC BEC positives.

Use the board's 5 V servo rail for analog elevons and the independent Pololu regulator for the receiver and GNSS. Verify all loaded voltages and keep positive rails separate.

Check motor and elevon response in both airframe orientations with propellers removed.

Output	Signal	Function	Endpoint	Driven item
S1	PWM	73	Port ESC signal input	Port throttle
S2	PWM	74	Starboard ESC signal input	Starboard throttle
S3	PWM	77	Port elevon servo	Port elevon
S4	PWM	78	Starboard elevon servo	Starboard elevon

Power, motor phases and peripheral links

Link	From	To	Connection notes
Power	4S pack / XT60	Wing Mini power board	Use the reviewed disconnect and protected 4S harness.
Power	Power board ESC feed	Port ESC VBAT	Size the branch against measured current. Isolate both ESC BEC positives.
Power	Power board ESC feed	Starboard ESC VBAT	Size the branch against measured current. Isolate both ESC BEC positives.
Power	Protected switched 4S branch	Pololu regulator input	Protect the branch and maintain common ground.
Power	Wing Mini 5 V servo rail	Port elevon servo	Analog servo positive and common signal ground.
Power	Wing Mini 5 V servo rail	Starboard elevon servo	Analog servo positive and common signal ground.
Power	Pololu regulated 5 V	CRSF receiver	Keep positive isolated from the FC and servo regulators.
Power	Pololu regulated 5 V	GNSS	Keep positive isolated and verify 4.7-5.2 V at the device under load.
Phase	Port ESC motor outputs	Port tractor motor	Three phases. Verify counter-rotating directions with propellers removed.
Phase	Starboard ESC motor outputs	Starboard tractor motor	Three phases. Verify counter-rotating directions with propellers removed.
Signal	UART1 / SERIAL1	CRSF receiver	Cross TX/RX, share ground and use peripheral 5 V.
Signal	UART3 / SERIAL3	GNSS	Cross TX/RX, share ground and use peripheral 5 V.
Signal	I²C	GNSS module compass	Match SDA/SCL and ground.
Signal	I²C reserve	Later airspeed sensor candidate	Confirm model, shared-bus compatibility and placement. The sensor is absent from the scene.

Checks to record

Measure the actual coupon fit, both cam and catch engagements, rail stock retention, hatch clearance, and repeated service cycles.

Measure axle and bridge-bolt fits, static and touchdown load capability, four-foot level and nose-up stability.

Confirm harness release and strain relief, propeller clearance, loaded elevon direction and travel, complete balance, range and failsafe.

Record guarded power, hover, both transition directions and landing separately after the exact bench article passes review.

Print inventory

File	Material	Qty	Envelope (mm)
parts/airframe/port-wing-1.stl	LW-PLA candidate	1	180.2 × 25.2 × 138.0
parts/airframe/port-elevon-1.stl	LW-PLA candidate	1	78.8 × 14.6 × 132.0
parts/airframe/port-wing-2.stl	LW-PLA candidate	1	160.3 × 21.8 × 139.0
parts/airframe/port-elevon-2.stl	LW-PLA candidate	1	70.7 × 12.6 × 133.0
parts/airframe/port-wing-3.stl	LW-PLA candidate	1	164.3 × 19.3 × 135.0
parts/airframe/port-esc-deck.stl	PETG candidate	1	83.0 × 38.0 × 3.0
parts/airframe/port-motor-firewall.stl	PETG candidate	1	42.0 × 42.0 × 4.0
parts/airframe/port-nacelle-shell.stl	LW-PLA candidate	1	45.0 × 46.0 × 54.0
parts/airframe/port-fin.stl	LW-PLA candidate	1	81.0 × 7.2 × 62.0
parts/airframe/port-servo-tray.stl	PETG candidate	1	38.0 × 32.0 × 3.0
parts/airframe/port-elevon-horn.stl	PETG candidate	1	16.0 × 15.0 × 3.0
parts/airframe/starboard-wing-1.stl	LW-PLA candidate	1	180.2 × 25.2 × 138.0
parts/airframe/starboard-elevon-1.stl	LW-PLA candidate	1	78.8 × 14.6 × 132.0
parts/airframe/starboard-wing-2.stl	LW-PLA candidate	1	160.3 × 21.8 × 139.0
parts/airframe/starboard-elevon-2.stl	LW-PLA candidate	1	70.7 × 12.6 × 133.0
parts/airframe/starboard-wing-3.stl	LW-PLA candidate	1	164.3 × 19.3 × 135.0
parts/airframe/starboard-esc-deck.stl	PETG candidate	1	83.0 × 38.0 × 3.0
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parts/airframe/starboard-nacelle-shell.stl	LW-PLA candidate	1	45.0 × 46.0 × 54.0
parts/airframe/starboard-fin.stl	LW-PLA candidate	1	81.0 × 7.2 × 62.0
parts/airframe/starboard-servo-tray.stl	PETG candidate	1	38.0 × 32.0 × 3.0
parts/airframe/starboard-elevon-horn.stl	PETG candidate	1	16.0 × 15.0 × 3.0
parts/airframe/port-upper-landing-pad.stl	PETG candidate	1	26.0 × 23.0 × 8.0
parts/airframe/port-lower-landing-pad.stl	PETG candidate	1	26.0 × 23.0 × 8.0
parts/airframe/starboard-upper-landing-pad.stl	PETG candidate	1	26.0 × 23.0 × 8.0
parts/airframe/starboard-lower-landing-pad.stl	PETG candidate	1	26.0 × 23.0 × 8.0
parts/airframe/nose-shell.stl	LW-PLA candidate	1	76.0 × 80.0 × 74.0
parts/airframe/center-shell-front-ring.stl	LW-PLA candidate	1	52.9 × 79.9 × 14.0
parts/airframe/center-shell-rear-ring.stl	LW-PLA candidate	1	52.9 × 79.9 × 12.0
parts/airframe/center-shell.stl	LW-PLA candidate	1	176.0 × 74.0 × 52.9
parts/airframe/center-hatch.stl	LW-PLA candidate	1	176.0 × 67.9 × 24.4
parts/airframe/aft-shell.stl	LW-PLA candidate	1	76.0 × 80.0 × 70.0
parts/airframe/nose-rail-shoe-port.stl	PETG candidate	1	15.0 × 14.0 × 16.8
parts/airframe/center-nose-rail-shoe-port.stl	PETG candidate	1	15.0 × 14.0 × 18.8
parts/airframe/center-aft-rail-shoe-port.stl	PETG candidate	1	15.0 × 14.0 × 18.8

File	Material	Qty	Envelope (mm)
parts/airframe/aft-rail-shoe-port.stl	PETG candidate	1	15.0 × 14.0 × 18.8
parts/airframe/nose-rail-shoe-starboard.stl	PETG candidate	1	15.0 × 14.0 × 16.8
parts/airframe/center-nose-rail-shoe-starboard.stl	PETG candidate	1	15.0 × 14.0 × 18.8
parts/airframe/center-aft-rail-shoe-starboard.stl	PETG candidate	1	15.0 × 14.0 × 18.8
parts/airframe/aft-rail-shoe-starboard.stl	PETG candidate	1	15.0 × 14.0 × 18.8
parts/airframe/battery-tray.stl	PETG candidate	1	135.0 × 54.0 × 3.0
parts/airframe/avionics-deck.stl	PETG candidate	1	40.0 × 34.4 × 3.0
parts/airframe/battery-rail-saddle-front-port.stl	PETG candidate	1	17.2 × 11.0 × 12.0
parts/airframe/battery-rail-saddle-front-starboard.stl	PETG candidate	1	17.2 × 11.0 × 12.0
parts/airframe/battery-rail-saddle-aft-port.stl	PETG candidate	1	17.2 × 11.0 × 12.0
parts/airframe/battery-rail-saddle-aft-starboard.stl	PETG candidate	1	17.2 × 11.0 × 12.0
parts/airframe/aft-rail-transfer-web.stl	PETG candidate	1	17.0 × 44.0 × 10.2
parts/airframe/landing-cradle-hub.stl	PETG candidate	1	38.2 × 38.6 × 7.0
parts/coupons/perch-c15-spigot.stl	PETG candidate	1	46.0 × 52.0 × 23.6
parts/coupons/perch-c15-receiver.stl	PETG candidate	1	46.7 × 52.0 × 21.5
parts/coupons/perch-c15-cam.stl	PETG candidate	1	19.2 × 6.8 × 21.3
parts/coupons/perch-c25-spigot.stl	PETG candidate	1	46.0 × 52.0 × 23.7
parts/coupons/perch-c25-receiver.stl	PETG candidate	1	46.7 × 52.0 × 21.5
parts/coupons/perch-c25-cam.stl	PETG candidate	1	19.2 × 6.8 × 21.3
parts/coupons/perch-c35-spigot.stl	PETG candidate	1	46.0 × 52.0 × 23.8
parts/coupons/perch-c35-receiver.stl	PETG candidate	1	46.7 × 52.0 × 21.5
parts/coupons/perch-c35-cam.stl	PETG candidate	1	19.2 × 6.8 × 21.3

Bill of materials

USD listings checked 2026-11-11. Shipping, tax and unpriced items require a separate budget.

Filament estimates cover all saved airframe plates, including supports and brims. Coupon material and measured print consumption are separate.

Printed parts and filament

Item	Qty	Specification
Perch hook and draw-lever fit coupons	1 set	Start with matched 0.15 / 0.25 / 0.35 mm nominal clearances. Inspect both hooks, lever sweep, hard-stop seating and catch insertion. print first
Nose and center fuselage modules	1 set	Keyed front joint, retained battery hatch and center equipment access. Exact IDs and quantities are in the print manifest. prototype CAD
Aft landing cradle and snap interfaces	1 assembly	Four-point nose-up stance. Capture both hooks with a metal bar, close the draw lever and engage the secondary catch. Record elevon clearance. prototype CAD
Left and right wings and elevons	1 set	Original 900 mm nominal swept wing with separately driven elevons. Keep elevons behind the motors in their wash. prototype CAD
Motor and servo adapters plus equipment supports	1 set	Fit 19 × 19 mm M3 motors and HS-65MG case envelopes. Isolate hot items from thin skins and route wires away from moving surfaces. prototype CAD
Lightweight shell filament	1 lot	LW-PLA class candidate. Select exact product and profile from shell weight, deformation and layer strength evidence. material pending $0.0375 per gram. 562.6 g estimate / $21.09. Gray 1.75 mm 0.8 kg spool PA08003. Candidate material. Bambu Studio estimate using the PolyLite LW-PLA candidate profile.
Rigid airframe filament (PETG)	1 lot	Use the saved Generic PETG airframe projects as the process reference. Choose and record the actual PETG spool. The three fit coupon projects have separate material estimates. material candidate Reference $0.0190 per gram. 121.2 g estimate / $2.30. Black 1.75 mm 1 kg spooled PETG HF candidate. Budget uses the Generic PETG slice estimate at the candidate PETG HF spool rate.
Module-local bonded rail shoes	8	Two nose, four center and two aft printed shoes. Trial-fit each part with the specified successor geometry. The 0.25 mm modeled face bond still needs material and load verification. Successor bench CAD
Aft rail-to-hub bridge and hub	1 set	Revised bridge and four angled 6.3 mm nominal landing-stock pockets. The aft shell's four 8.2 mm ports provide clearance. Check bore alignment and loads with the actual cradle. Successor bench CAD
Battery rail saddles	4	Keep the restrained battery and saddles on the center module. Check actual lead bends, receiver clearance and service access through both cam sweeps. Successor bench CAD

Propulsion and onboard electronics

Item	Qty	Specification
EMAX ECO II 2807 1700KV motor	2	ECO228071700. 19 × 19 mm M3, M5 prop nut, 18 AWG 200 mm leads. Measure case and motor screw depth. sourced candidate Reference $19.49 per motor
Gemfan Flash 7042 two-blade matched props	1 pack	177.8 mm nominal diameter, 5 mm bore, 7.5 mm hub, 2 CW + 2 CCW. Fit one of each and verify hand and retention. sourced candidate Reference $4.99 per 4-pack
Hobbywing Skywalker 60A V2 ESC	2	V2 part 30216101. 3-6S, 60 A vendor continuous, 73 × 30 × 12 mm, 68 g. Use PWM and isolate both ESC BEC positive wires. sourced candidate Reference $34.99 per ESC
Tattu 4S 2300 mAh XT60 LiPo	1	TA-75C-2300-4S1P-XT60. 14.8 V nominal, 105 × 35 × 29 mm nominal, 270 g nominal. Confirm installed fit and discharge envelope. restrained bench candidate Reference $37.09 per battery
Main disconnect and two-branch power harness	1 set	Select exact protection, contacts, wire gauges and branch limits by measured current and thermal rise. Installed unrestricted output is held. release blocked
SpeedyBee F405 WING MINI V1.2	1	37 × 26 × 14 mm nominal, 5.2 V/2 A FC and 5 V/4 A servo rail. Four PWM outputs, UART1 CRSF, UART3 GNSS, I²C compass. sourced candidate Reference
Hitec HS-65MG metal-gear servo	2	23.6 × 11.6 × 24 mm case. Use 5 V analog PWM and confirm servo torque reserve and travel with actual linkages. sourced candidate Reference $35.99 per servo
RadioMaster RP3 V2 ELRS receiver	1	2.4 GHz, 5 V, CRSF. 22 × 13 × 4 mm body and two antennas. sourced candidate Reference $19.99 per receiver
Holybro Micro M10 GNSS and compass	1	34 × 28 × 11 mm and 16 g with case, UART GNSS and I²C compass. Confirm delivered compass and header. sourced candidate Reference
Pololu D24V22F5 peripheral regulator	1	Pololu #2858. Nominal 5 V for GNSS and receiver. Isolate the positive from both FC rails and verify loaded voltage. sourced candidate Reference $26.95 per regulator
MicroSD and harness service leads	1 set	ArduPilot-compatible log storage, USB data lead and keyed UART/I²C harness; check board and peripheral pinouts. source pending
Holybro MS4525DO and PT40 pitot	1 set	Transition instrumentation candidate. Review local airflow, hoses, electrical compatibility, stock and calibration. later test candidate Reference $46.59 per sensor

Airframe stock and linkages

Item	Qty	Specification
Carbon spar and reinforcement stock	1 set	CAD uses 9 × 7 mm main and nacelle tubes and nominal 6 mm landing struts. The module-local fuselage rails have their own line below. Check fit and loads against the exact successor build. source pending
Hook bars and cam axle hardware	2 sets	Each seam has one nominal 3 mm hook bar, two short nominal 3 mm pivot pins and one independent nominal 2 mm catch pin. Cut lengths and keeper specification require measured fit. source pending
Elevon hinges horns and retained pushrods	2 sets	Use positive hinge and linkage retention and control horns matched to the reviewed load and geometry. Final travel remains open. source pending
Module-local carbon rail stocks	6	Nominal 8 mm OD / 6 mm ID carbon stock. Per side: nose 18.75 mm, center 177.50 mm and aft 31.00 mm. The printed sockets are nominal 8.25 mm. Measure the actual fits. Stock and structural qualification pending

Fasteners and assembly supplies

Item	Qty	Specification
Motor screws and wing-root fasteners	1 set	M3 motor mount screws with engagement sized from the actual firewall and motor. Select wing-root retention and locking hardware after physical fit. source pending
Battery restraints pads and wire protection	1 set	Padded strap with structural anchor and axial restraint, strain relief, abrasion guards and equipment-retention hardware. source pending
Rear bridge M3 bolts, spacers and retention hardware	2 sets	Two nominal 1.25 mm spacers sit in the rear bridge stack. Determine actual bolt grip and positive retention after dry fit and review touchdown loads. Sourced hardware fit pending

Radio and charging gear

Item	Qty	Specification
RadioMaster TX16S Mark II Mode 2	1	Choose the internal 2.4 GHz ELRS variant. Supply a compatible radio battery and confirm firmware and failsafe. sourced candidate Reference $219.99 per radio
Gens ace iMars III Pro balance charger	1	Use the supplied compatible charge and balance leads and the battery-maker instructions for standard 4S LiPo. sourced candidate Reference

Workshop equipment

Item	Qty	Specification
Bambu Lab P1S with 0.4 mm nozzle	1	Use documented plate and profiles, calipers and a spring scale for fit coupons. bench equipment Reference
Propulsion and electrical measurement kit	1 set	Multimeter, current-limited supply, calibrated wattmeter, scale, tachometer, thermometer, remote cutoff and rated restrained thrust fixture. bench equipment