

ScoutCrux 500 and 650

Folding inspection quadcopter. Brief, requirement status, screening calculations, CAD mass ledgers, bought-in record, verification history and the change record from 500 to 650.

Status. Prepared by an AI agent driving SOLIDWORKS 2026 through its API in a lab demonstration. Not checked or approved. Screening calculations with stated assumptions; not a structural assessment, propulsion qualification or flight clearance. Bought-in parts are envelopes from published nominal dimensions, not supplier CAD.

1. Brief

A heritage-survey team needs a packable camera drone to document inaccessible roofs. It must carry a replaceable camera cassette, keep its balance after a camera swap, and allow a damaged arm to be replaced without dismantling the centre body.

Change request: increase the motor diagonal from 500 to 650 mm and the payload allowance from 250 to 500 g (gross 2 to 3 kg) while retaining the camera interface and the electronics mounting pattern.

2. Requirement status

ScoutCrux 500

ID	Requirement	Target	Result	Method	Status
R01	Motor diagonal	500 mm	500.0 mm measured between motor axes	CAD measurement	PASS
R02	Gross mass	<= 2 kg incl. 250 g payload allowance and 90 g harness	CAD 1.819 kg; with harness and full allowance 2.046 kg	CAD mass with supplier/allocated overrides + allowances	FAIL
R04	Propeller discs	clear each other and the body	min disc gap 99.5 mm; disc to body 23.7 mm	CAD positions, plan view	PASS
R05	Static thrust	>= 9.8 N per rotor (2:1)	needs the supplier thrust curve for the exact motor/prop/voltage	supplier test data (not yet available)	OPEN
R06	Hover endurance	>= 12 min on 80 % of nominal energy	13.1 min estimated (11.0 min at FM 0.5)	momentum theory estimate	ESTIMATE
R07	Motor deflection	<= 0.75 mm (design limit 0.60 mm)	0.376 mm with 16x1.0 tube	beam + 0.1 deg hinge allowance	PASS
R09	CG	within 10 mm of centre	2.2 mm; 4.2 mm with the full payload allowance	CAD mass properties	PASS
R11	Camera ground clearance	> 0 at full 20 mm foot stroke	13 mm	CAD extents	PASS
R12	Stowed envelope	350 x 220 x 220 mm, props and legs off	266 x 164 x 139 mm	CAD, Folded configuration	PASS
R13	Change rebuilds	no broken mates or references	0 mate errors, 0 unexpected interferences	SOLIDWORKS rebuild + interference detection	PASS

ScoutCrux 650

ID	Requirement	Target	Result	Method	Status
R01	Motor diagonal	650 mm	650.0 mm measured between motor axes	CAD measurement	PASS
R02	Gross mass	<= 3 kg incl. 500 g payload allowance and 90 g harness	CAD 2.426 kg; with harness and full allowance 2.903 kg	CAD mass with supplier/allocated overrides + allowances	PASS
R04	Propeller discs	clear each other and the body	min disc gap 129.4 mm; disc to body 56.9 mm	CAD positions, plan view	PASS
R05	Static thrust	>= 14.7 N per rotor (2:1)	needs the supplier thrust curve for the exact motor/prop/voltage	supplier test data (not yet available)	OPEN
R06	Hover endurance	>= 12 min on 80 % of nominal energy	12.7 min estimated (10.6 min at FM 0.5)	momentum theory estimate	ESTIMATE
R07	Motor deflection	<= 0.75 mm (design limit 0.60 mm)	0.571 mm with 22x1.5 tube	beam + 0.1 deg hinge allowance	PASS
R09	CG	within 10 mm of centre	4.2 mm; 8.6 mm with the full payload allowance	CAD mass properties	PASS
R11	Camera ground clearance	> 0 at full 20 mm foot stroke	16 mm	CAD extents	PASS
R12	Stowed envelope	350 x 220 x 220 mm, props and legs off	384 x 171 x 146 mm	CAD, Folded configuration	FAIL
R13	Change rebuilds	no broken mates or references	0 mate errors, 0 unexpected interferences	SOLIDWORKS rebuild + interference detection	PASS

3. Screening calculations

Assumptions: E = 69,000.0 N/mm² (6061-T6), yield 240.0 N/mm², hinge allowance 0.1° out-of-plane rotation, figure of merit 0.6, drive efficiency 0.8, avionics 15.0 W, usable energy 80%, ρ = 1.225 kg/m³.

Arm stiffness (R07)

$\delta = F \cdot L^3 / (3 \cdot E \cdot I)$ for the tube from the root socket to the motor, plus $L_{pin} \cdot \theta_{hinge}$. $I = \pi(OD^4 - ID^4)/64$.

Case	Tube	F (N)	L free (mm)	I (mm ⁴)	Beam (mm)	Hinge (mm)	Total (mm)	Status
500	16x1.0	15.0	121.49	1331.2	0.098	0.278	0.376	passed
650	16x1.0	22.5	196.49	1331.2	0.619	0.409	1.029	failed: exceeds R07
650	20x1.0	22.5	196.49	2701.0	0.305	0.409	0.715	failed: inside R07 but leaves no allowance for chassis compliance
650	22x1.5	22.5	196.49	5101.9	0.162	0.409	0.571	passed

Thrust and hover power (R05, R06)

Variant	Gross (kg)	Hover thrust per rotor	2:1 per rotor	Ideal power per rotor	Electrical power	Usable energy	Endurance
500	2.0	4.905 N	9.81 N (1000 gf)	30.8 W	271.9 W	59.2 Wh	13.1 min
650	3.0	7.357 N	14.715 N (1500 gf)	43.6 W	378.1 W	79.9 Wh	12.7 min

$P_{ideal} = T^{1.5} / \sqrt{2pA}$. An estimate for screening only: the real figure needs the measured propulsion curve, flight profile, wiring losses, battery sag and temperature.

Landing and hinge (R11, R08)

Variant	Average reaction	Provisional peak	Per leg	Arm bending	Reserve on yield	Pin shear	Lug bearing
500	69.6 N	139.2 N	34.8 N	25.4 MPa	9.4	5.3 MPa	6.2 MPa
650	104.4 N	208.9 N	52.2 N	22.1 MPa	10.8	11.7 MPa	13.7 MPa

4a. Mass ledger, ScoutCrux 500 (CAD)

Part	Description	Qty	Each (g)	Total (g)	Material	Mass source
SC-B03-4S-5000	BATTERY 4S 5000 MAH LIPO ENVELOPE	1	500.0	500.0	Plain Carbon Steel	Allocated
SC-B01-2216-920	MOTOR 2216-CLASS 920 KV OUTRUNNER (HOLYBRO AIR2216 II CANDIDATE)	4	68.0	272.0	6061-T6 (SS)	Allocated / published nominal
SC-110	HINGE CLEVIS, ARM FOLD	4	33.2	132.7	6061-T6 (SS)	CAD volume × density
SC-120	ARM ROOT, PIVOT AND TUBE SOCKET	4	27.5	110.1	6061-T6 (SS)	CAD volume × density
SC-B07	GIMBAL CAMERA SIYI A8 MINI (ENVELOPE)	1	95.0	95.0	6061-T6 (SS)	Published 95 g
SC-140	MOTOR POD AND LEG SOCKET, PA12-GF	4	20.9	83.6	Nylon 6/10	CAD volume × density
SC-104	CHASSIS PLATE 2.0 6061-T6	1	81.1	81.1	6061-T6 (SS)	CAD volume × density
SC-101	UPPER SHELL, BATTERY BAY	1	68.9	68.9	ABS PC	CAD volume × density
SC-130	ARM TUBE 16 x 1 WALL, L 129.0	4	16.4	65.6	6061-T6 (SS)	CAD volume × density
SC-B04	FLIGHT CONTROLLER PIXHAWK 6C MINI (ENVELOPE)	1	42.4	42.4		Published 42.4 g
SC-103	BATTERY COVER	1	41.9	41.9	ABS PC	CAD volume × density
SC-102	LOWER SHELL, GIMBAL RECESS	1	35.6	35.6	ABS PC	CAD volume × density
SC-F01	SHOULDER SCREW ISO 7379 6 x 22 M5	4	8.2	32.9	AISI 4340 Steel, normalized	Computed
SC-B02-10x4.5-CW	PROPELLER 10x4.5 CW (ILLUSTRATIVE BLADE)	2	16.0	32.0	Nylon 6/10	Allocated
SC-B02-10x4.5-CCW	PROPELLER 10x4.5 CCW (ILLUSTRATIVE BLADE)	2	16.0	32.0	Nylon 6/10	Allocated
SC-B05	ESC 4-IN-1 (ENVELOPE)	1	30.0	30.0		Allocated 30 g
SC-B06	RECEIVER, TELEMETRY AND GNSS (ENVELOPE)	1	25.0	25.0		Allocated 25 g
SC-F03	INDEX PLUNGER 4 mm PIN (ENVELOPE)	4	6.0	24.0	AISI 4340 Steel, normalized	Computed
SC-150	LANDING LEG, FRONT, L 91	2	11.0	22.1	Nylon 6/10	CAD volume × density
SC-160	CAMERA CASSETTE	1	15.9	15.9	6061-T6 (SS)	CAD volume × density
SC-F05	SCREW ISO 4762 M3 x 10	16	1.0	15.5	AISI 4340 Steel, normalized	Computed
SC-F04	SCREW ISO 4762 M3 x 8	16	0.9	13.8	AISI 4340 Steel, normalized	Computed
SC-151	LANDING LEG, REAR, L 43	2	5.7	11.3	Nylon 6/10	CAD volume × density
SC-170	AVIONICS TRAY	1	11.0	11.0	Nylon 6/10	CAD volume × density
SC-155	FOOT, TPU 85A, COMPLIANT	4	2.0	8.2	Rubber	CAD volume × density
SC-F02	BUSH 8 x 6 x 5.6 SINTERED BRONZE	8	1.0	8.2	Tin Bearing Bronze	Computed
SC-180	BATTERY RAIL WITH POSITION SCALE	1	4.1	4.1	Nylon 6/10	CAD volume × density
SC-F08	ISOLATOR 10 x 6 RUBBER (ENVELOPE)	4	0.5	1.9	Rubber	Computed
SC-F06	NUT ISO 4032 M3	16	0.1	1.8	AISI 4340 Steel, normalized	Computed

CAD 1819 g + harness allowance 90 g = 1909 g with the modelled camera. With the full 250 g payload allowance (modelled payload 113 g): **2046 g** against 2000 g.

FAIL

4b. Mass ledger, ScoutCrux 650 (CAD)

Part	Description	Qty	Each (g)	Total (g)	Material	Mass source
SC-B03-6S-4500	BATTERY 6S 4500 MAH LOW-PROFILE LIPO ENVELOPE	1	690.0	690.0	Plain Carbon Steel	Allocated
SC-B01-2814-700	MOTOR 2814-CLASS 700 KV OUTRUNNER (CANDIDATE CLASS, SKU NOT FROZEN)	4	108.0	432.0	6061-T6 (SS)	Allocated / published nominal
SC-130	ARM TUBE 22 x 1.5 WALL, L 202.5	4	52.8	211.3	6061-T6 (SS)	CAD volume × density
SC-110	HINGE CLEVIS, ARM FOLD	4	33.2	132.7	6061-T6 (SS)	CAD volume × density
SC-140	MOTOR POD AND LEG SOCKET, PA12-GF	4	32.6	130.6	Nylon 6/10	CAD volume × density
SC-120	ARM ROOT, PIVOT AND TUBE SOCKET	4	31.7	126.6	6061-T6 (SS)	CAD volume × density
SC-B07	GIMBAL CAMERA SIYI A8 MINI (ENVELOPE)	1	95.0	95.0	6061-T6 (SS)	Published 95 g
SC-104	CHASSIS PLATE 2.0 6061-T6	1	81.1	81.1	6061-T6 (SS)	CAD volume × density
SC-101	UPPER SHELL, BATTERY BAY	1	68.9	68.9	ABS PC	CAD volume × density
SC-B02-13x5.5-CCW	PROPELLER 13x5.5 CCW (ILLUSTRATIVE BLADE)	2	28.0	56.0	Nylon 6/10	Allocated
SC-B02-13x5.5-CW	PROPELLER 13x5.5 CW (ILLUSTRATIVE BLADE)	2	28.0	56.0	Nylon 6/10	Allocated
SC-B04	FLIGHT CONTROLLER PIXHAWK 6C MINI (ENVELOPE)	1	42.4	42.4		Published 42.4 g
SC-103	BATTERY COVER	1	41.9	41.9	ABS PC	CAD volume × density
SC-102	LOWER SHELL, GIMBAL RECESS	1	35.6	35.6	ABS PC	CAD volume × density
SC-F01	SHOULDER SCREW ISO 7379 6 x 22 M5	4	8.2	32.9	AISI 4340 Steel, normalized	Computed
SC-B05	ESC 4-IN-1 (ENVELOPE)	1	30.0	30.0		Allocated 30 g
SC-B06	RECEIVER, TELEMETRY AND GNSS (ENVELOPE)	1	25.0	25.0		Allocated 25 g
SC-F03	INDEX PLUNGER 4 mm PIN (ENVELOPE)	4	6.0	24.0	AISI 4340 Steel, normalized	Computed
SC-150	LANDING LEG, FRONT, L 91	2	11.0	22.1	Nylon 6/10	CAD volume × density
SC-160	CAMERA CASSETTE	1	15.9	15.9	6061-T6 (SS)	CAD volume × density
SC-F05	SCREW ISO 4762 M3 x 10	16	1.0	15.5	AISI 4340 Steel, normalized	Computed
SC-F04	SCREW ISO 4762 M3 x 8	16	0.9	13.8	AISI 4340 Steel, normalized	Computed
SC-151	LANDING LEG, REAR, L 43	2	5.7	11.3	Nylon 6/10	CAD volume × density
SC-170	AVIONICS TRAY	1	11.0	11.0	Nylon 6/10	CAD volume × density
SC-155	FOOT, TPU 85A, COMPLIANT	4	2.0	8.2	Rubber	CAD volume × density
SC-F02	BUSH 8 x 6 x 5.6 SINTERED BRONZE	8	1.0	8.2	Tin Bearing Bronze	Computed
SC-180	BATTERY RAIL WITH POSITION SCALE	1	4.1	4.1	Nylon 6/10	CAD volume × density
SC-F08	ISOLATOR 10 x 6 RUBBER (ENVELOPE)	4	0.5	1.9	Rubber	Computed
SC-F06	NUT ISO 4032 M3	16	0.1	1.8	AISI 4340 Steel, normalized	Computed

CAD 2426 g + harness allowance 90 g = 2516 g with the modelled camera. With the full 500 g payload allowance (modelled payload 113 g): **2903 g** against 3000 g.

PASS

5. Bought-in record

Part	Supplier / class	Source	Mass source	Geometry	Verification
SC-B01-2216-920	Holybro 2216-920 class	docs.holybro.com (candidate)	Allocated / published nominal	Envelope from published nominal dimensions; not supplier CAD	Envelope only; exact revision and interfaces not verified
SC-B02-10x4.5-CW	APC class 10x4.5	apcprop.com geometry data (illustrative)	Allocated	Envelope from published nominal dimensions; not supplier CAD	Envelope only; exact revision and interfaces not verified
SC-B03-4S-5000	TBD 4S-5000	Candidate class; SKU not selected	Allocated	Envelope from published nominal dimensions; not supplier CAD	Envelope only; exact revision and interfaces not verified
SC-B07	SIYI A8 mini	siyi.biz specification	Published 95 g	Envelope from published nominal dimensions; not supplier CAD	Envelope only; exact revision and interfaces not verified
SC-B05	TBD 4-in-1 ESC class	Candidate class	Allocated 30 g	Envelope from published nominal dimensions; not supplier CAD	Envelope only; exact revision and interfaces not verified
SC-B06	TBD Radio/GNSS class	Candidate class	Allocated 25 g	Envelope from published nominal dimensions; not supplier CAD	Envelope only; exact revision and interfaces not verified
SC-B04	Holybro Pixhawk 6C Mini Model-A	docs.holybro.com technical specification	Published 42.4 g	Envelope from published nominal dimensions; not supplier CAD	Envelope only; exact revision and interfaces not verified
SC-B02-10x4.5-CCW	APC class 10x4.5	apcprop.com geometry data (illustrative)	Allocated	Envelope from published nominal dimensions; not supplier CAD	Envelope only; exact revision and interfaces not verified
SC-B03-6S-4500	TBD 6S-4500	Candidate class; SKU not selected	Allocated	Envelope from published nominal dimensions; not supplier CAD	Envelope only; exact revision and interfaces not verified
SC-B01-2814-700	TBD 2814-700 class	docs.holybro.com (candidate)	Allocated / published nominal	Envelope from published nominal dimensions; not supplier CAD	Envelope only; exact revision and interfaces not verified
SC-B02-13x5.5-CCW	APC class 13x5.5	apcprop.com geometry data (illustrative)	Allocated	Envelope from published nominal dimensions; not supplier CAD	Envelope only; exact revision and interfaces not verified
SC-B02-13x5.5-CW	APC class 13x5.5	apcprop.com geometry data (illustrative)	Allocated	Envelope from published nominal dimensions; not supplier CAD	Envelope only; exact revision and interfaces not verified

6. Verification history

ScoutCrux 500: verification history (1 October 2026)

Transcribed from the verify.py console output of each pass (the JSON of the earlier passes was overwritten by later runs; the final JSON is out/cad-500.json).

```
## Pass 1 (first complete assembly)
- Mass 2.096 kg: R02 (2.0 kg) failed. Structure about 1.04 kg against a 550 g allocation.
- Prop mate over-defined (axis + plane): mate error 48 in all four arm modules.
- Interference, largest findings (mm3): upper shell vs battery cover 5,991 (the battery-bay cut had severed the upper shell's tail into a second body); upper shell vs battery 3,648; upper shell vs chassis plate 570; cover vs battery 435; lower shell vs camera cassette 361; clevis vs shells 214 / 162; motor-screw heads buried in the pod 40 (16 instances).
- Folded: propellers clashed with the other arms (props had to come off for packing, per R12).

## Pass 2 (after lightening and the first fixes)
- Mass 1.938 kg (R02 passed). CG offset 1.8 mm.
- Remaining: chassis plate inside the upper-shell walls (11 overlaps), clevis flange vs cover, rear clevis nuts vs the bay wall, latch block vs battery (432).

## Pass 3
- Upper shell split moved to the plate's top face (the plate became a visible layer between the shells); rear arm plane dropped 0.5 mm; flange trimmed; rails moved under the battery.
- Remaining: rear clevis nut and screw tip against the tapering upper-shell wall (4-5 mm3).

## Pass 4 (accepted)
- Relief notch over the rear clevis hardware; bay narrowed to 30.5 mm half-width.
- 0 mate errors, 0 unexpected interferences (20 modelled thread engagements), 1.941 kg, CG 1.6 mm from centre, folded envelope 266 x 164 x 139 mm.

## 650 first change run (evidence/history/cad-650-first-check.json)
- Screw-head pockets in the motor pod were not tied to the tube size: at OD 22 the heads were buried (16 x 40 mm3).
- The 2814 motor pattern (19 x 25) put a screw head against the tube end (4 instances).
- The 13-inch blade root dipped below the propeller hub into the motor cap (8 instances).
- Fixes: pocket depth linked to "OD"/2 - 1; tube stop linked to "PAT_A"/2 + 4.5 (so LEN follows the motor); blade root chord reduced. The 500 was rebuilt with the same linked features and the change re-run from a fresh copy.
```

7. Change record, 500 to 650

Time	Step	Evidence
04:44:36	change request	{"diag": "500 -> 650 mm", "gross": "2 -> 3 kg", "payload": "250 -> 500 g", "retained": "camera interface, electronics mounting patte
04:44:36	copied the 500 design	{"files": 36, "source": "D:\\ParaCrux-ModelTest\\ScoutCrux\\cad\\SC-500", "target": "D:\\ParaCrux-ModelTest\\ScoutCrux\\cad\\SC-650"
04:44:38	repointed references	{"assemblies": 6, "replaced": 59}
04:44:38	tube 16x1.0: 1.029 mm	{"status": "failed: exceeds R07", "beam": 0.619, "joint": 0.409}
04:44:38	tube 20x1.0: 0.715 mm	{"status": "failed: inside R07 but leaves no allowance for chassis compliance", "beam": 0.305, "joint": 0.409}
04:44:38	tube 22x1.5: 0.571 mm	{"status": "passed", "beam": 0.162, "joint": 0.409}
04:44:38	motor pattern check	{"pod": [16.0, 19.0], "motor": [19.0, 25.0], "status": "refused: pod pattern does not match the motor"}
04:44:38	battery 6S-5000: height 52 mm, bay allows 38.9 mm	{"status": "refused: does not fit the retained bay"}
04:44:38	battery 6S-4500: height 38 mm, bay allows 38.9 mm	{"status": "fits"}
04:46:03	SC-130: OD 22, ID 19, LEN 202.49	{"mass_g": 52.8}
04:46:05	SC-120: OD 22	{"mass_g": 31.7}
04:46:07	SC-140: OD 22, PAT_A 19, PAT_B 25, MOTOR_D 35	{"mass_g": 32.6}
04:46:11	replaced SC-B01-2216-920 in SC-A21.SLDASM	{"by": "SC-B01-2814-700.SLDPRT", "ok": true}
04:46:12	replaced SC-B02-10x4.5-CW in SC-A21.SLDASM	{"by": "SC-B02-13x5.5-CW.SLDPRT", "ok": true}
04:46:15	replaced SC-B01-2216-920 in SC-A22.SLDASM	{"by": "SC-B01-2814-700.SLDPRT", "ok": true}
04:46:17	replaced SC-B02-10x4.5-CCW in SC-A22.SLDASM	{"by": "SC-B02-13x5.5-CCW.SLDPRT", "ok": true}
04:46:20	replaced SC-B01-2216-920 in SC-A23.SLDASM	{"by": "SC-B01-2814-700.SLDPRT", "ok": true}
04:46:22	replaced SC-B02-10x4.5-CCW in SC-A23.SLDASM	{"by": "SC-B02-13x5.5-CCW.SLDPRT", "ok": true}
04:46:25	replaced SC-B01-2216-920 in SC-A24.SLDASM	{"by": "SC-B01-2814-700.SLDPRT", "ok": true}
04:46:26	replaced SC-B02-10x4.5-CW in SC-A24.SLDASM	{"by": "SC-B02-13x5.5-CW.SLDPRT", "ok": true}
04:46:32	replaced SC-B03-4S-5000 in SC-A10.SLDASM	{"by": "SC-B03-6S-4500.SLDPRT", "ok": true}

8. Open items

- R05: obtain supplier thrust data for the exact motor, propeller and voltage of each variant; repeat at low voltage and temperature.
- R06: replace the momentum estimate with a propulsion-curve power model and a flight profile.
- R12 (650): folded length exceeds the 350 mm case; decide between a longer case and a two-piece arm.
- Modal frequencies against rotor speed bands, fatigue of the hinge, FEA of arm root, chassis and landing gear with contact at the joints.
- Replace envelopes with verified supplier CAD; confirm mounting interfaces, connector positions and redistribution terms.