# Airframe and Structural Design

Folding airframe: G10 central fuselage, 20 mm carbon booms, tool-less deployment

ABSTRACT

The Atilim UAV airframe is a folding design built around a two-plate G10 fiberglass central fuselage carrying 20 mm carbon fiber arms. Strategic cutouts patterned into the top and bottom chassis plates achieve weight reduction and simplify internal wire management, and 12 heavy-duty spacers integrated between the plates act as rigid, load-bearing internal beams against the torsional twisting produced by high yaw movements and peak thrust loads. G10 was selected because it offers an excellent strength-to-weight ratio while remaining RF-transparent, which prevents a Faraday cage effect around the internal telemetry and GNSS receivers. The arms fold on commercial RJX 20 mm brackets and the landing gear uses a custom telescopic leg with a spring-loaded folding mechanism, so the aircraft deploys tool-lessly; the leg-to-arm articulated joints are 3D printed in high-impact CF-PLA to maximize structural resilience and absorb kinetic energy during hard landings, and the motor mounts are machined in house from aerospace-grade 6061 aluminum to press-fit onto the 20 mm booms. Folded, the aircraft collapses to a 13 x 13 inch footprint, which complies with standard airline "Personal Item" baggage constraints.

# 1 AIRFRAME CONFIGURATION

The aircraft is a folding multirotor. A flat central fuselage — two profiled G10 fiberglass plates separated by spacers — sits at the middle, and the main carbon fiber arms run out from it. Each arm carries a CNC-machined aluminum motor mount and a telescopic landing leg on an articulated joint. Figure 1 shows the aircraft in its deployed flight configuration.

Six requirements shaped the structure, and every part described in this document answers at least one of them:

- Weight reduction, and internal wire management that does not fight the structure.
- RF transparency around the internal telemetry and GNSS receivers.
- Resistance to torsional twisting during high yaw movements and peak thrust loads.
- Tool-less assembly, so the aircraft can be deployed for immediate rapid response.
- Absorption of kinetic energy at the landing gear during hard landings.
- A folded footprint that complies with standard airline "Personal Item" baggage constraints.

Sections 2 to 4 follow the structure outward from the fuselage to the arms and the manufactured parts; Section 5 covers the folded transport configuration. Table 1 collects the material choices in one place, with the property each part was selected for.

**Figure 1.** The airframe in its deployed flight configuration, from the CAD model. What to read from it is the geometry the folding architecture has to produce on demand: arms out to full span, telescopic legs extended below. The central body is enclosed by a canopy here, so the plate stack described in Section 2 is not visible in this view.

# 2 CENTRAL FUSELAGE

The central fuselage is constructed entirely from G10 fiberglass laminate. Structurally it is a stack: a top and a bottom profiled plate held apart by spacers, with every other structural member on the aircraft terminating there. What defines it is the cutout pattern in the plates, the choice of G10, and the 12 spacers that tie the two plates into one box.

### 2.1 Plate Geometry and Mass Reduction

Strategic cutouts were patterned into both the top and the bottom chassis plate. The pattern does two jobs at once: it removes laminate to bring plate mass down, and it simplifies internal wire management, so harnesses pass through the structure instead of around it. Figure 2 shows the two plate profiles.

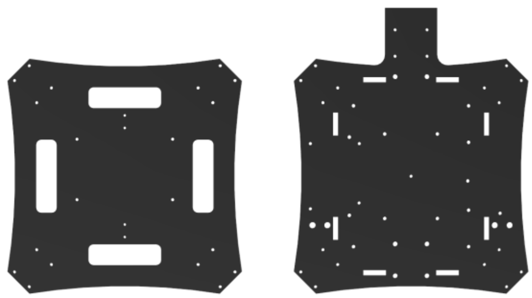

**Figure 2.** The top and bottom chassis plate profiles, from the CAD model. What to look at is how much laminate the slot pattern removes, and that the two plates are not identical.

### 2.2 Why G10

G10 was specifically selected because it offers an excellent strength-to-weight ratio while remaining RF-transparent. Both properties were required. The second is the one that concerns the avionics: a conductive shell would produce a Faraday cage effect around the internal telemetry and GNSS receivers, and a fiberglass laminate prevents it.

### 2.3 Spacer Columns and Torsional Stiffness

High yaw movements and peak thrust loads try to twist the two plates relative to one another. To counteract that torsional twisting, 12 heavy-duty spacers are integrated between the plates, acting as rigid, load-bearing internal beams. Figure 3 shows the assembled stack, with the harness running through the gap the spacers open.

> *The torsional stiffness argument above is design intent. No analysis, load case or test result for that path is reported in this document.*

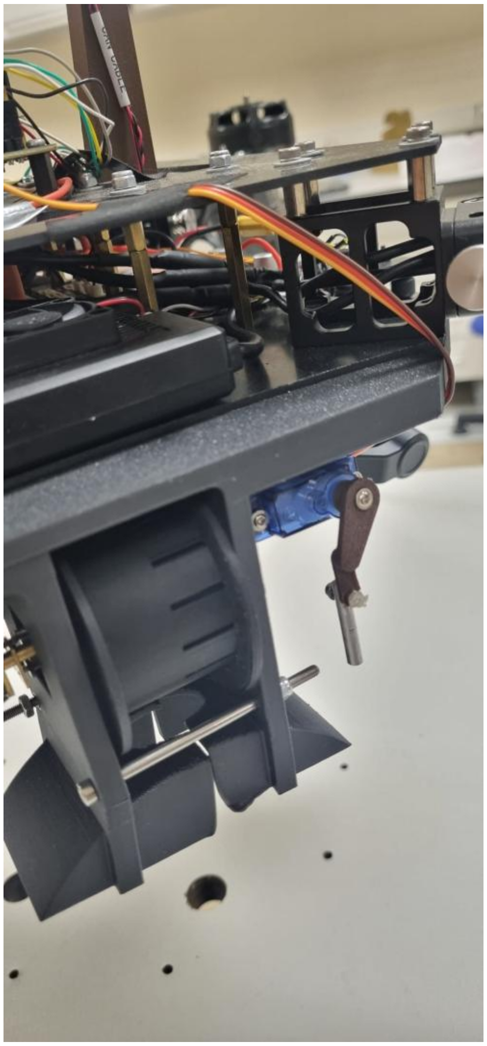

**Figure 3.** The assembled plate stack, photographed from the side. The spacers standing between the two plates are the load-bearing members described here, and the wiring runs through the gap they open. The photograph also shows a servo and a mechanism below the lower plate that this document does not describe.

## 3 FOLDING ARCHITECTURE AND TOOL-LESS ASSEMBLY

Designed for immediate rapid response, the aircraft has a complete tool-less folding topology: every joint that changes between transport and flight moves by hand, with nothing to unbolt. Figure 1 and Figure 5 are the two ends of that motion, the same aircraft deployed and folded.

### 3.1 Arms and Hinges

The main carbon fiber arms fold on commercial RJX 20 mm foldable brackets, selected for quick deployment. These hinges are the airframe's commercial off-the-shelf content; Section 4 covers what was made in house instead, and where the split falls.

### 3.2 Landing Gear and the Impact Path

The landing gear is custom. Each leg is telescopic and carries a spring-loaded folding mechanism, so the gear collapses against the airframe for transport and extends for flight; Figure 1 shows the legs extended, Figure 5 the same legs collapsed. The articulated joints connecting these legs to the main arms are 3D printed in high-impact CF-PLA (carbon fiber reinforced PLA) to maximize structural resilience and to absorb kinetic energy during hard landings.

## 4 MANUFACTURING: BOUGHT AND MADE

The build splits cleanly. The folding hinges are commercial off-the-shelf components; the motor mounts were engineered entirely from scratch.

Each motor mount is a critical load-transfer component, manufactured in house from aerospace-grade 6061 aluminum on a 3-axis CNC machine. The mounts are specially designed for the team's propulsion system and press-fit securely onto the 20 mm carbon fiber booms, so motor thrust and torque pass into the boom through that press-fit joint. Figure 4 shows the mount geometry.

**Figure 4.** The in-house CNC motor mount, shown as a CAD model. The bolt pattern and the lightening holes sit on the circular face; the semicircular saddle on the right is the press-fit interface to the 20 mm carbon boom.

Table 1 sets that make-or-buy split beside the rest of the material choices, one row per part, and marks the one part whose material the design documentation does not yet state.

**Table 1.** Airframe materials and the property each part was selected for. Read it alongside the make-or-buy split: the folding hinges are bought, the motor mounts are machined in house.

| Item | Material or part | Property it was selected for |
|---|---|---|
| Top and bottom chassis plates | G10 fiberglass laminate | Strength-to-weight ratio; RF-transparent, which prevents a Faraday cage effect around the internal telemetry and GNSS receivers |
| Inter-plate spacers (12 off) | Heavy-duty spacers; material not stated in the source | Act as rigid, load-bearing internal beams against torsional twisting |

| Item | Material or part | Property it was selected for |
|---|---|---|
| | | under high yaw movements and peak thrust loads |
| Main arms | Carbon fiber; 20 mm booms | Primary arm structure; 20 mm is the boom size both the RJX brackets and the motor mounts are made to fit |
| Arm folding brackets | RJX 20 mm foldable brackets (COTS) | Tool-less quick deployment |
| Motor mounts | Aerospace-grade 6061 aluminum, 3-axis CNC, in house | Press-fit onto the 20 mm booms; specially designed for the team's propulsion system and for the thrust and torque it transfers |
| Leg-to-arm articulated joints | High-impact CF-PLA (carbon fiber reinforced PLA), 3D printed | Structural resilience; absorbs kinetic energy during hard landings |
| Landing legs | Custom telescopic leg with spring-loaded folding mechanism | Collapses against the airframe for transport, extends for flight |

## 5 TRANSPORT CONFIGURATION AND PORTABILITY

The folding architecture exists for this result. The RJX brackets and the custom telescopic legs together allow this autonomous platform to collapse into a compact footprint: folded for transport, the system measures 13 x 13 inches, which complies with standard airline "Personal Item" baggage constraints. That is the logistical argument for the whole folding design.

Deployed, the same airframe opens to a wide and stable aerodynamic stance. Figure 5 shows the folded transport mode; set against Figure 1 it gives the honest measure of what the hinges and the telescopic legs are doing, since the two figures are the same aircraft.

**Figure 5.** The aircraft folded for transport, from the CAD model. The arms have swung back alongside the body and the legs have collapsed against it; this is the 13 x 13 inch configuration referred to in the text.