HAWk Modular RC Wing Airplane

Neues Fliegen e.V.

VIEW IN BROWSER

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Summary

A profesionally designed, well-tested flying wing with modular parts that is easy to print and fun to fly.

34.50 hrs	28 pcs	0.25 mm 0.20 mm	0.60 mm	PLA PET	481 g	Prusa MK3/S/S+

Hobby & Makers > RC & Robotics

Tags: fpvdrone remotecontrol rc droneframe rcairplane airplane fpv drone makeitfly ardupilot betaflight inav modelaircraft aircraft radiocontrol modelairplane fpvwing wing rcaircraft

Introduction

“HAWk” is a flying wing concept designed for RC hobbyists that feels just as good to fly as an RC plane made from conventional materials. It’s printed in light weight PLA (LW-PLA) with most pieces in vase mode for maximum weight savings and quick replacement part sourcing.

In case you print this plane

This project is a team effort - so the best thing you can do for us is to post your make here on Printables so we can feel your appreciation. Thank you very much!

An accompanying build instruction document is attached in the files section here on printables. If anything is left unclear, feel free to ask us in the comment section or write us a message. We are excited to see your builds fly!

Motivation

HAWings - the team behind this build - is always looking for new exciting engineering challenges. As a student team composed out of engineers, 3D printing geeks and RC hobbyists this project was (and will continue to be) an exciting experience to develop a almost completely 3D printed plane that actually flys well - all while being lightweight, fast and easy to replicate as an accessible platform for our needs (and some RC fun as well).

Features

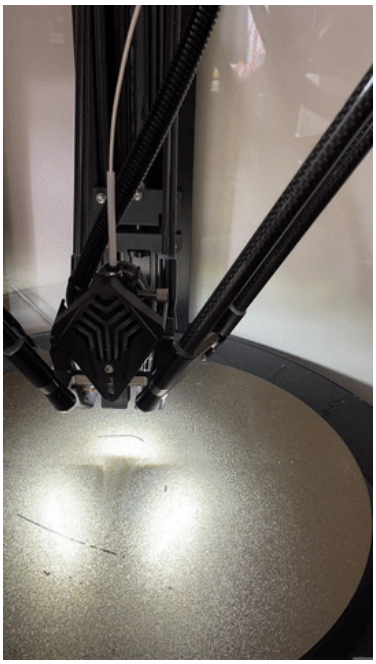
Predictable flight characteristics

HAWk flies very smoothly at all speeds and is easy to maneuver even without a flight controller. Throw launches work without problems, also on landing the good flight characteristics are apparent. Stalls are predictable and easy to avoid, and HAWk can be recovered very quickly and easily after a stall.

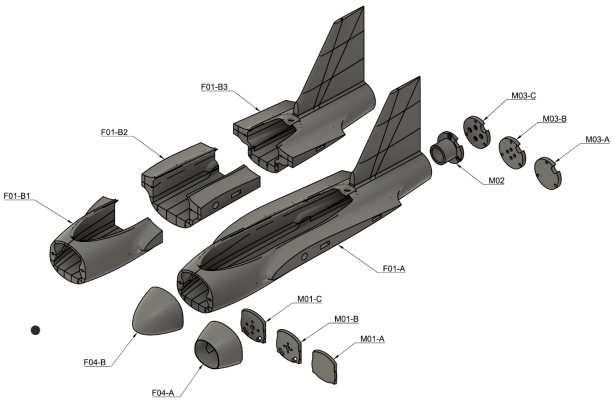
Vase-Mode printing

The flying wing is completely designed to be suitable for painless 3D printing on any machine. It is divided into multiple small segments that can fit almost any print bed.

Most of the LW-PLA parts are printable in vase mode. This makes for cleanly printed parts with no seams, stringing or oozing, even on cheaper 3D printers. Hence the outcome is seamless and the airplane itself lightweight - all while being structurally safe, reliable and fast to print.



Modularity



HAWk is designed to be modular - this way each HAWk that is created will fit the owners needs as much as possible.

Currently, this includes the following options:

- Motor mounting either in the front nose or in the rear
- Different motor mounting plates

For more upcoming options, see the “Changelog” section.

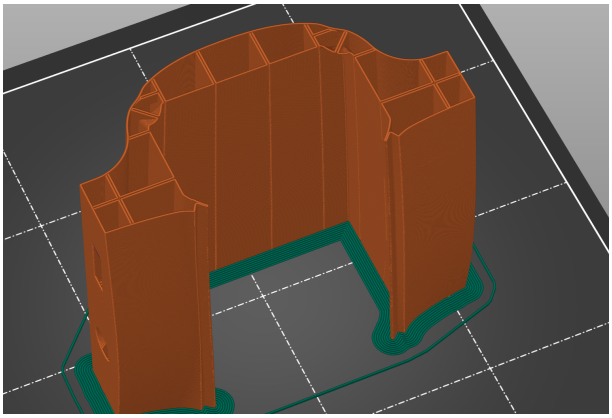
No heavy machinery required

Printable on a Prusa Mini - all you need is at least 18x18x18cm of print volume. Optionally, if your printer allows a build volume of at least 400mm (like the FLSUN V400), you can print the main fuselage in one piece instead of three.

Built-in lightweight structures

One of the main challenges was keeping the design compatible with vase mode printing. The wing parts for example are precisely subdivided so

they work best with this design philosophy, especially where the elevon hinges are located.

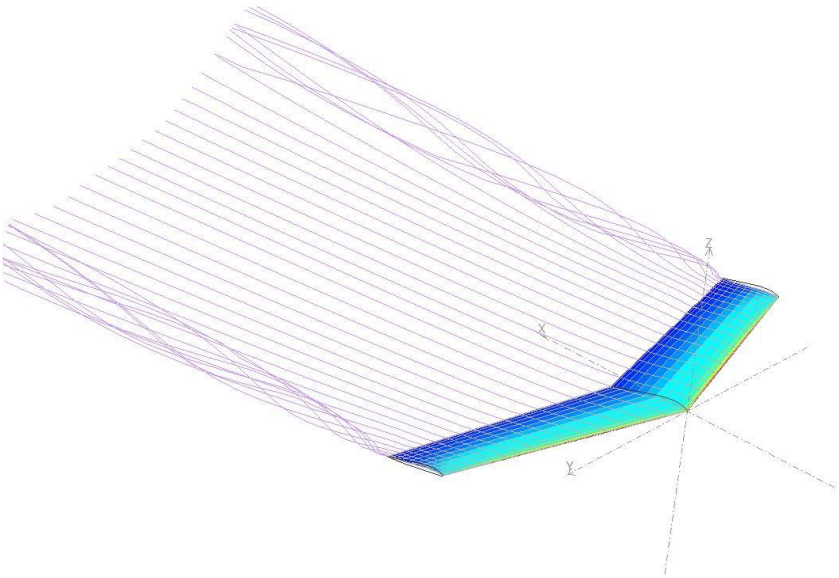


To reinforce the bodies with the least material possible, we opted for an unusual approach that makes use of the LW-PLA material: first, the design is modeled as a full body. Afterwards, extremely narrow cuts are made into the body that form the reinforcement structures.

When printing, the vase mode automatically sets the infill to 0%, resulting in these small cuts to be recognized as walls. In PrusaSlicer, the slice gap closing radius is set to 0 - this makes the two walls between the cuts connect and merge, and build up the reinforcing structure that makes this concept possible.

Aerodynamics

The design also delivers decent flight characteristics - a result of us doing the math (twice, or even thrice!). Within XFLR5 we adjusted the plane geometry and the airfoil, so that HAWk flies as well as we could make it, can easily handle low speeds and still is a lot of fun with the weight of different types of onboard equipment (batteries, FPV system, extra sensors, ...) and does not demand the pilot unnecessarily.



With these calculations even the first flight tests of HAWk were already successful enough to please all our pilots and to verify our design. The characteristics of the plane, even in windy conditions, are very stable and predictable and showed that our calculations were correct. We still wouldn't strongly recommend HAWk to absolute beginners in this hobby, as we don't think flying wings are particularly well suited for beginners in general.

Datasheet

Wingspan	1300 mm
Root chord	220 mm
Tip chord	160 mm
Sweep angle	20°
twist	-1.2°
Airfoil	HS3090
CG	126 mm behind leading edge (marked on the fuselage)
Take-off mass	800 - 1200 g (depending on battery size and build materials)
Wing loading	39.2 g/dm2 - 58.8 g/dm2
Stall speed	7.5 m/s (with 800 g take-off mass)

Recommended print settings for PrusaSlicer

- Optimized for 0.6 mm nozzles (you can use 0.6mm extrusion width with a 0.4 mm nozzle, but we heighly suggest printig with a 0.6 mm nozzle)
- There are project files (.3mf) for all printable parts (with the recommended printsettings). If you want to slice the parts yourself, in generall the settings are
    - Vase mode parts
        - check “Spiral vase”
        - 0.25mm layer height
        - Slice gap closing radius = 0
    - For PETG / ASA parts use Prusa defaults with 4 perimeters

Hardware Setup

Tested

Cheap 5” drone hardware

This setup was what we had on hand when building the prototypes. It is not very efficient, but anyone building model airplanes or drones should own something similar already. This is the setup you can see on the current photos. The flight time was around 10 minutes on a 4S 1200mAh pack in cold weather conditions.

Motor: Any 2306 or 2207, ~2400KV

Prop: Any 5” tri-blade or 6” bi-blade drone prop with decent pitch

ESC: Any with 30A+

Battery: 4S 1300mAh LiPo

6s - 5” drone hardware - RECOMMENDATION

This setup is currently our recommended configuration. By running a 6s drone motor on 4s, it enables the usage of a larger propeller due to the reduced RPM. This provides the optimal balance between power and efficiency..

Motor: Any 2306 or 2207, 1500 - 1700KV (tested with eco II 2306-1700KV)

Prop: 7" or 8" biblade (tested with HQProp 8x5)

ESC: Any with 30A+

Battery: 4S 1300mAh LiPo

High efficiency

This setup gives you significantly longer flight time but comes with somewhat limited power. Also the Motor gets quite warm on full throttle.

Motor: T-Motor 2203.5, 1500kv or StanFPV 2203, 1500kv

Prop: 7" biblade (tested with gemfan 7042)

ESC: Any with 30A+

Battery: 4S 1300mAh LiPo

Unverified

High efficiency speed

This setup is intended to just require a different prop and battery as the high efficiency setup, and should achieve air speeds of up to 100km/h.

Motor: T-Motor 2203.5, 1500kv or StanFPV 2203 1500kv

Prop: 5" or 6" bi-blade

ESC: Any with 40A+

Battery: 6S 800-900mAh LiPo

Roadmap

- Mounting options for different servo sizes

FPV Version

- Nose with mounting options for an FPV camera and VTX
- Mounts for flight controllers of the usual stack sizes and antennas

UAV-platform version

- Accommodate for more Sensors in the platform
    - Nose with space for an airspeed sensor
    - Space for ground lidar
- Downfacing camera

Updates

16.04.2023

First successful flight with the upcoming FPV nose module

Changelog

Version 1.0.1 - June 2023

- Bugfixes - Elevon Parts R1, R2 and R3 are correctly mirrored now (STLs, 3MF and GCODE)
- Removed 2mm carbon rod from building instructions since it was not necesarry

Version 1.0 - March 2023

Initial release

New parts

- Fuselage one-piece and three-piece
- Five-piece wings
- Three-piece Elevons
- Front nose modules: simple, motor mount
- Rear motor mount receiver
- Motor mounts:
  - Front: no holes, 12mm holes, 16mm+19mm holes
  - Rear: no holes, 12mm holes, 16mm+19mm holes
- Wing servo trays
- Two-piece wing spar mount

Credits

CAD drawing and technical design	Julian Wollenberg - Printables
Aerodynamic design	Nils Raaf - Printables
Documentation, documentation art, photography, videography	Philipp Molitor - Printables / GitHub Jan Philip Dittmann Fabian Kühn Cornelia Esch
Complained about life while glueing parts	Sebastian Sy

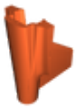
Model files

HAWk V1.0.1 - STL 36 files

hawk-v10-f01-a-fuselage-one-piece.stl

hawk-v10-f01-b1-fuselage-segment-front.stl

hawk-v10-f01-b2-fuselage-segment-middle.stl



hawk-v10-f01-b3-fuselage-segment-rear.stl

hawk-v10-f02-fuselage-cover-front.stl

hawk-v10-f03-fuselage-cover-rear.stl

hawk-v10-f04-a-fuselage-nose-with-motor-mount.stl

hawk-v10-f04-b-fuselage-nose-simple.stl

hawk-v10-w01-wing-segment-l1.stl

hawk-v10-w02-wing-segment-l2.stl

hawk-v10-w03-wing-segment-l3.stl

hawk-v10-w04-wing-segment-l4.stl

hawk-v10-w05-wing-segment-l5.stl

hawk-v10-w06-wing-segment-r1.stl

hawk-v10-w07-wing-segment-r2.stl

hawk-v10-w08-wing-segment-r3.stl

hawk-v10-w09-wing-segment-r4.stl

hawk-v10-w10-wing-segment-r5.stl

hawk-v10-e01-elevon-segment-l1.stl

hawk-v10-e02-elevon-segment-l2.stl

hawk-v10-e03-elevon-segment-l3.stl

hawk-v10-e04-elevon-segment-r1.stl

hawk-v10-e05-elevon-segment-r2.stl

hawk-v101-e06-elevon-segment-r3.stl

hawk-v10-m01-a-motor-bracket-front-no-holes.stl

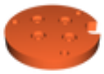
hawk-v10-m01-b-motor-bracket-front-12mm-diameter-m2.stl

hawk-v10-m01-c-motor-bracket-front-16mm-and-19mm-di... .stl

hawk-v10-m02-motor-mount-rear-receiver.stl

hawk-v10-m03-a-motor-bracket-rear-no-holes.stl

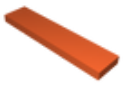
hawk-v10-m03-b-motor-bracket-rear-12mm-diameter-m2.stl



hawk-v10-m03-c-motor-bracket-rear-16mm-and-19mm-dia… .stl

hawk-v10-u01-wing-spar-connector-l.stl

hawk-v10-u02-wing-spar-connector-r.stl



hawk-v10-u03-wing-pin.stl

hawk-v10-u05-servo-tray-r.stl

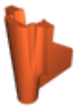
hawk-v10-u04-servo-tray-l.stl

HAWk V1.0.1 - 3MF 28 files

hawk-v10-f01-a-fuselage-one-piece.3mf

hawk-v10-f01-b1-fuselage-segment-front.3mf

hawk-v10-f01-b2-fuselage-segment-middle.3mf



hawk-v10-f01-b3-fuselage-segment-rear.3mf

hawk-v10-f02-fuselage-cover-front.3mf

hawk-v10-f03-fuselage-cover-rear.3mf

hawk-v10-f04-a-fuselage-nose-with-motor-mount.3mf

hawk-v10-f04-b-fuselage-nose-simple.3mf

hawk-v10-w01-wing-segment-l1.3mf

hawk-v10-w02-wing-segment-l2.3mf

hawk-v10-w03-wing-segment-l3.3mf

hawk-v10-w04-wing-segment-l4.3mf

hawk-v10-w05-wing-segment-l5.3mf

hawk-v10-w06-wing-segment-r1.3mf

hawk-v10-w07-wing-segment-r2.3mf

hawk-v10-w08-wing-segment-r3.3mf

hawk-v10-w09-wing-segment-r4.3mf

hawk-v10-w10-wing-segment-r5.3mf

hawk-v10-e01-elevon-segment-l1.3mf

hawk-v10-e02-elevon-segment-l2.3mf

hawk-v10-e03-elevon-segment-l3.3mf

hawk-v101-e04-elevon-segment-r1.3mf

hawk-v101-e05-elevon-segment-r2.3mf

hawk-v101-e06-elevon-segment-r3.3mf

hawk-v10-u01-u02-wing-spar-connector-lr.3mf

hawk-v10-u03-u04-u05-wing-servo-mounts-wing-pins.3mf

hawk-v10-m01-a-m01-b-m01-c-motor-mount-front.3mf

☐ All possible variants included, delete the ones you don't need.

hawk-v10-m02-m03-a-m03-b-m03-c-motor-mount-rear.3mf

Print files

HAWk V1.0.1 - Prusa MK3s 28 files

hawk-v10-f01-a-fuselage-one-piece_06n_025mm_pla_gen... .gcode

PLA 0.60 mm 0.25 mm 5.79 hrs 91 g Prusa MK3/S/S+

hawk-v10-f01-b1-fuselage-segment-front_06n_025mm_pl... .gcode

PLA 0.60 mm 0.25 mm 1.54 hrs 23 g Prusa MK3/S/S+

hawk-v10-f01-b2-fuselage-segment-middle_06n_025mm_p... .gcode

PLA 0.60 mm 0.25 mm 1.63 hrs 24 g Prusa MK3/S/S+

hawk-v10-f01-b3-fuselage-segment-rear_06n_025mm_pla... .gcode

PLA 0.60 mm 0.25 mm 2.90 hrs 44 g Prusa MK3/S/S+

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hawk-v10-f03-fuselage-cover-rear_06n_025mm_pla_mk3s... .gcode

PLA 0.60 mm 0.25 mm 0.61 hrs 6 g Prusa MK3/S/S+

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hawk-v10-u03-u04-u05-wing-servo-mounts-wing-pins_06… .gcode

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hawk-v101-e06-elevon-segment-r3_06n_025mm_pla_mk3s_... .gcode

PLA 0.60 mm 0.25 mm 0.84 hrs 8 g Prusa MK3/S/S+

Other files

hawk-v101-bom-building-instructions.pdf

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