Pilatus B4

one of the most famous and beautiful aerobatic gliders

User Guide

Figure 1: 3D-printed Pilatus B4 with electric engine

Parameter	3D-printed Pilatus B4	Original Pilatus B4 (PC-11AF)
Scale:	1 : 6.5	1:1
Wingspan:	2308 mm	15 m
Length:	1011 mm	6.57 m
Wing airfoil:	RG 8	NACA 64_3–618
Empty weight:	1100 g	230kg
Takeoff weight:	[1350…2000] g	max. 350kg
Wing area:	37.7 dm^2	14.05 m^2
Wing load:	[35.81…53.04] g/dm^2	~21,35 kg/m^2
Control:	radio controlled, 4-5 channels	1 pilot

Content:

The Original

The history of the B4 began in the 1960s at Rheintalwerke G. Basten in Germany, designed by Manfred Kueppers, Ingo Herbst and Rudolf Reinke. Only two prototypes were produced with maiden flight on November 7, 1966. Six years later, the Swiss company Pilatus Aircraft bought the license and modified the design such that simple aerobatics were permitted. The first aircraft of this type made its maiden flight on May 5th, 1972. Shortly thereafter, it went into serial production under the name PC-11 and quickly conquered the hearts of many pilots due to its robustness, pleasant all-round flight characteristics and approval for aerobatics. Further enhancements followed in the coming years with the PC-11A and finally the PC-11AF which allows unrestricted aerobatics. With the latter, Johan Gustafsson became world champion in the advanced class in 2010.

Figure 2: Pilatus B4 (PC-11), Alf van Beem, CC0, via Wikimedia Commons

What you get

This is a thoroughly designed 3D printable scale version of the original Pilatus B4. I spent considerable amount of time with prototype testing and refinement to improve printability, surface quality, scale characteristics, flight characteristics, and rigidity. The latter is mandatory for aerobatics and realized by carbon tubes and rods of different size combined with a spring steel wing connector.
Flexible usability was a further key design parameter. The Pilatus B4 can be built

- with or without wheels
- with different fuselage nose options:
  - pure glider
  - tow release
  - powered with electric engine
- with reduced weight for improved thermal flight using the additionally provided LW-PLA STL files for the tail rudders.

The wings and the horizontal stabilizer can be easily removed from the fuselage for transport. The connectors were designed based on proven solutions used since many years for RC-controlled gliders.

Flight video with electric engine

3D print files

The package includes a complete set of STL files, a set of PrusaSlicer project files, and the hereof generated gcode. PrusaSlicer is a powerful open-source software that can be used for free. The project files were created with version 2.7.0 and contain all detailed print settings required to optimally print each airplane part. Exemplary project files can be downloaded at rc3dmarket.com.

Note: If you want to use a different slicer software, please make sure to check and reapply all part-dependent print settings provided in the PrusaSlicer project files. Otherwise, some parts may not print as desired.

STL	STL stands for Standard Tessellation Language, a file format that describes the surface geometry of a three-dimensional object. High resolution STL files are included for all printable parts. Optional LW-PLA STL files are available for low-weight printing of the tail rudders to save weight for thermal flight.
Project files	Multiple STL files can be combined into a single project file (3mf) and “print job” (gcode). Specific slicer settings can be applied to e.g., increase the stability of a certain part area or improve the printability of an area with large overhang angle. The package includes 20 project files (9 are optional) with full access to all specific slicer settings used for each component. All project files can be easily modified with the graphical user interface of PrusaSlicer to comply with your 3D printer in terms of print volume, parameters, and print material.
Gcode	For each project file and each LW-PLA printable part corresponding gcode files are provided to minimize your preparation time. Please note that these gcode files were generated for the Prusa i3 MK3S. For many 3D printers and filaments, the gcode should just work fine. If you experience issues with the print quality, I recommend having a closer look at the slicer parameters to optimize the gcode for your printer.
Autodesk Fusion 360 design files	For the servo and battery holders the original F3D design file is provided. You may use the demo version of Fusion 360 to modify the holders according to your needs (e.g., when using a servo or battery with different dimensions).

Figure 3 depicts an exploded view of the Pilatus B4. Together with the following part list it provides an overview of all 3D printable parts. The color code of the index numbers shows to which project file and gcode the part belongs.

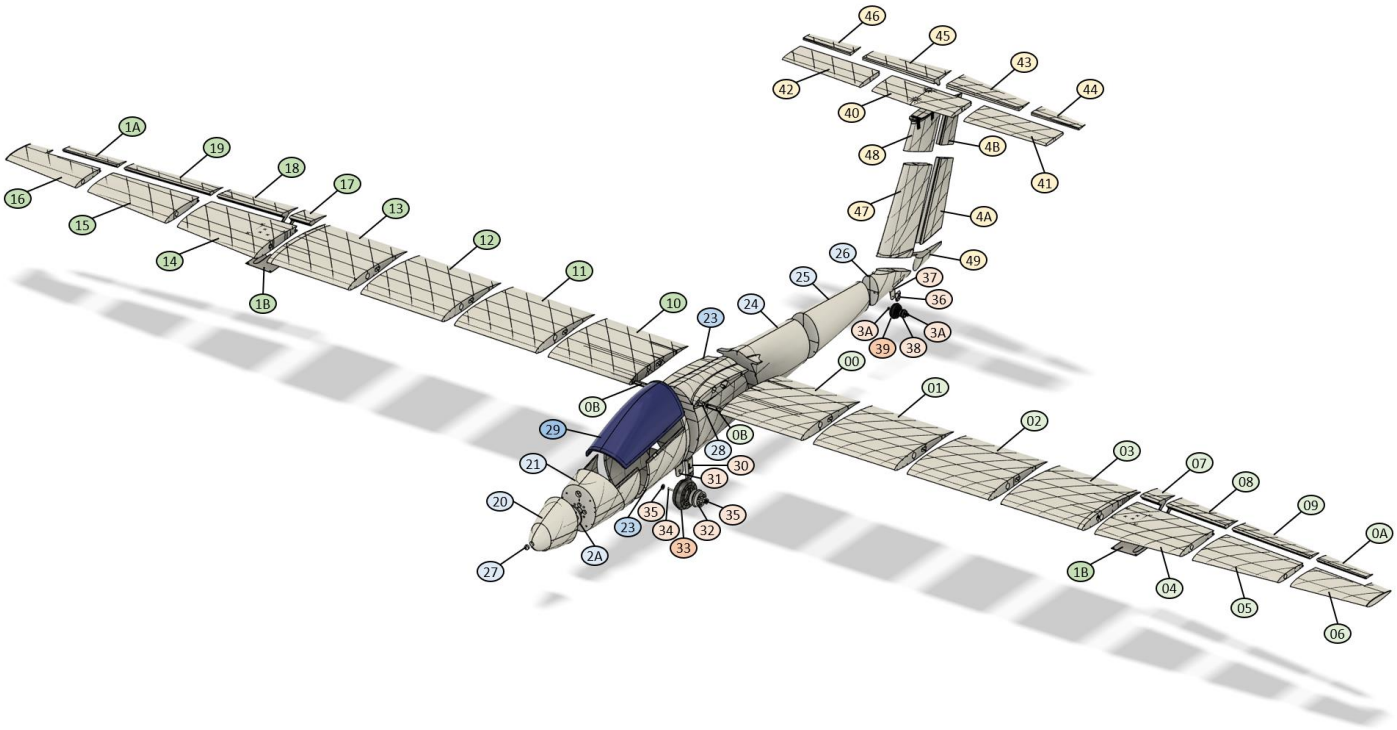
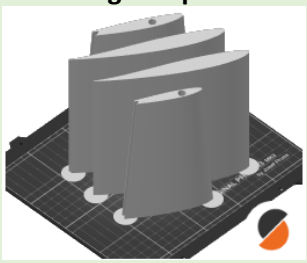
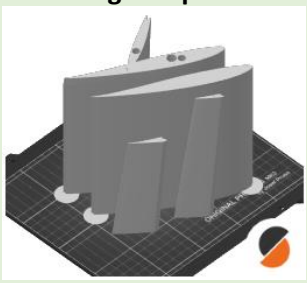
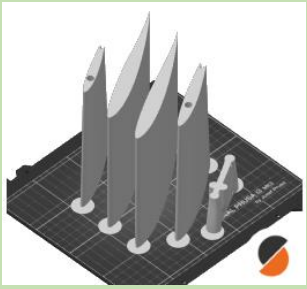
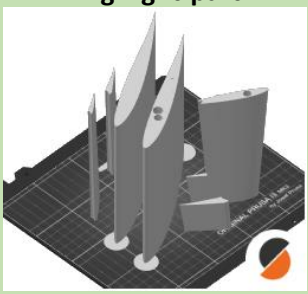
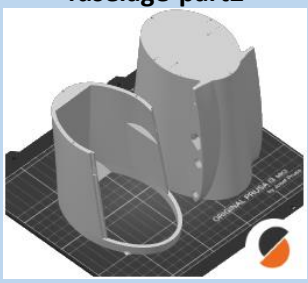
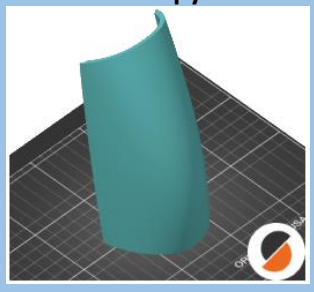
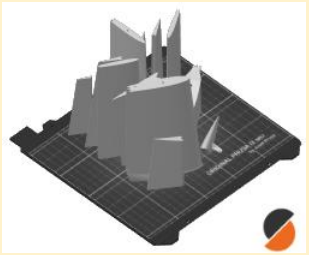
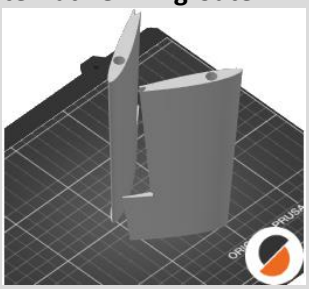
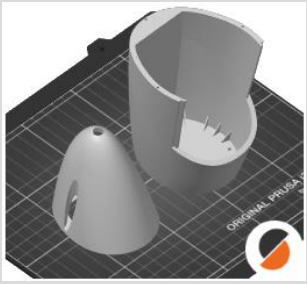
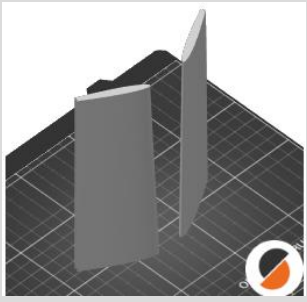
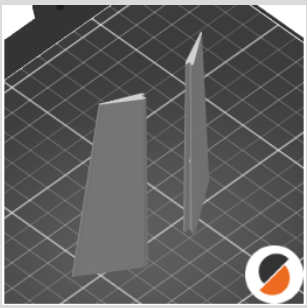
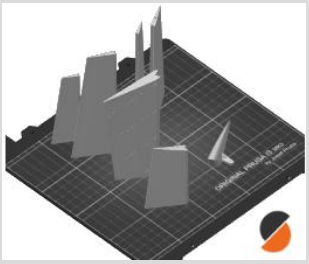
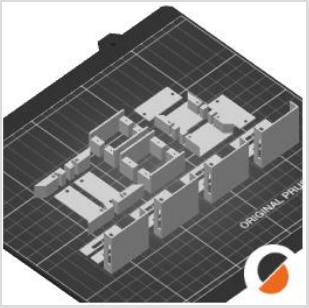


Figure 3: Exploded view with labeled airplane parts

Project (.3mf/.gcode)	Part name (.stl)	Index	Print weight
wing-left-part1  time: 16h 52m, weight: 142g	wing-inner-0-l wing-inner-1-l wing-outer-0-l wing-outer-1-l wing-clip-male (2x)	00 01 04 05 0B	48 g 42 g 29 g 22 g 2 g
wing-left-part2  time: 14h 29m, weight: 120g	wing-inner-2-l wing-inner-3-l wing-outer-2-l aileron-0-l aileron-1-l aileron-2-l aileron-3-l	02 03 06 07 08 09 0A	42 g 44 g 14 g 3 g 7 g 7 g 3 g

wing-right-part1  time: 17h 10min, weight: 144g	wing-inner-0-r wing-inner-1-r wing-outer-0-r wing-outer-1-r servo-cover (2x)	10 11 14 15 1B	48 g 42 g 28 g 22 g 4 g
wing-right-part2  time: 14h 27m, weight: 120g	wing-inner-2-r wing-inner-3-r wing-outer-2-r aileron-0-r aileron-1-r aileron-2-r aileron-3-r	12 13 16 17 18 19 1A	42 g 44 g 14 g 3 g 7 g 7 g 3 g
fuselage-part1  time: 14h 36m, weight: 126g	fuselage-0 fuselage-1 fuselage-4 fuselage-5 fuselage-6 fuselage-nose-cutout wing-clip-female (3x) engine-mount-wedge (optional) wing-clip-test (optional)	20 21 24 25 26 27 28 2A 2B	19 g 38 g 31 g 24 g 11 g <1 g 1 g 2 g 2 g
fuselage-part2  time: 11h 53m, weight: 104g	fuselage-2 fuselage-3	22 23	32 g 72 g
canopy  time: 2h 38m, weight: 15g	canopy	29	15 g

optional: wheels  time: 1h 0m, weight: 9g	main-wheel-axle-bearing-l main-wheel-axle-bearing-r main-wheel-rim main-wheel-axle main-wheel-washer (2x) tail-wheel-axle-bearing-l tail-wheel-axle-bearing-r tail-wheel-rim tail-wheel-washer (2x)	30 31 32 34 35 36 37 38 3A	3 g 3 g 4 g <1 g <1 g <1 g <1 g 1 g <1 g
optional: tires  time: 47m, weight: 8g	main-wheel-tire tail-wheel-tire	33 39	7 g 1 g
tail  time: 15h 6m, weight: 118g	hori-stabilizer-middle hori-stabilizer-l hori-stabilizer-r elevator-0-l elevator-1-l elevator-0-r elevator-1-r vert-stabilizer-lower vert-stabilizer-upper rudder-lower rudder-middle rudder-upper	40 41 42 43 44 45 46 47 48 49 4A 4B	16 g 12 g 12 g 8 g 3 g 8 g 3 g 23 g 15 g 3 g 10 g 5 g
alternative: wing-outer-2-l+r  time: 3h 21m, weight: 28g	wing-outer-2-l wing-outer-2-r Use this project file to print the wing tip (outer 2 cm) in a different color. The printer will pause, and you can change the filament.	07 17	14 g 14 g

alternative: fuselage-alternatives  time: 6h 13m, weight: 56g	fuselage-0-engine fuselage-1-no-drilling	20-1 21-1	21 g 40 g
alternative: hor-stabilizer-l+r  time: 3h 30m, weight: 26 g	hori-stabilizer-l hori-stabilizer-r Use this project file to print the stabilizer tip (outer 0.6 cm) in a different color. The printer will pause, and you can change the filament.	41 42	13 g 13 g
alternative: elevator-1-l+r  time: 1h 25m, weight: 6g	elevator-1-l elevator-1-r Use this project file to print the stabilizer tip (outer 6 mm) in a different color. The printer will pause, and you can change the filament.	44 46	3 g 3 g
alternative: tail-lw  weight: 22g	elevator-lw-0-l elevator-lw-1-l elevator-lw-0-r elevator-lw-1-r rudder-lower rudder-middle rudder-upper Print each part separately!	43-1 44-1 45-1 46-1 49-1 4A-1 4B-1	4 g 2 g 4 g 2 g 1 g 6 g 3 g
optional: holders  time: 3h 41min, weight: 33g	battery-receiver-holder-0 (4x) battery-receiver-holder-1 (8x) servo-holder-DS843MG-fuselage (2x) servo-holder-DS843MG-wing-bottom (2x) servo-holder-DS843MG-top (2x) servo-holder-DS939MG-fuselage (2x) servo-holder-DS939MG-wing-l (2x) servo-holder-DS939MG-wing-r (2x) servo-holder-DS939MG-top (2x) Fusion 360 design file provided to adjust holder dimensions to own radio control.	50 51 52 53 54 55 56 57 58	11 g 2 g 4 g 4 g 1 g 5 g 2 g 2 g 2 g

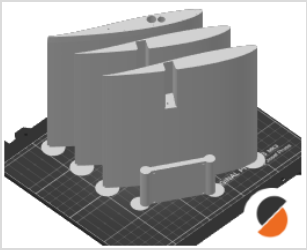
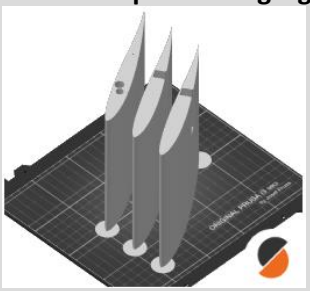
alternative: spoiler-wing-left  time: 15h 33min, weight: 133g	wing-inner-spoiler-1-l wing-inner-spoiler-2-l wing-inner-spoiler-3-l spoiler-servo-cover-print (2x)	60 61 62 63/73	42 g 43 g 44 g 4 g
alternative: spoiler-left  time: 2h 1min, weight: 20g	spoiler-bottom-l spoiler-mid-l spoiler-top-l spoiler-pleuel1-front-l spoiler-pleuel1-back-l spoiler-pleuel2-front-l spoiler-pleuel2-back-l spoiler-axle-bottom (2x) spoiler-nail (2x) servo-holder-DS843MG-wing-bottom servo-holder-DS843MG-top	64 65 66 67 68 69 6A 6B 6C 53 54	9 g 2 g 5 g <1 g <1 g <1 g <1 g <1 g <1 g 4 g 1 g
alternative: spoiler-wing-right  time: 15h 14min, weight: 129g	wing-inner-spoiler-1-r wing-inner-spoiler-2-r wing-inner-spoiler-3-r	70 71 72	42 g 43 g 44 g
alternative: spoiler-right  time: 2h 1min, weight: 20g	spoiler-bottom-r spoiler-mid-r spoiler-top-r spoiler-pleuel1-front-r spoiler-pleuel1-back-r spoiler-pleuel2-front-r spoiler-pleuel2-back-r spoiler-axle-bottom (2x) spoiler-nail (2x) servo-holder-DS843MG-wing-bottom servo-holder-DS843MG-top	74 75 76 77 78 79 7A 7B 7C 53 54	9 g 2 g 5 g <1 g <1 g <1 g <1 g <1 g <1 g 4 g 1 g

Figure 4: Fresh from the printer - main print parts including wheels (engine version 1.0)

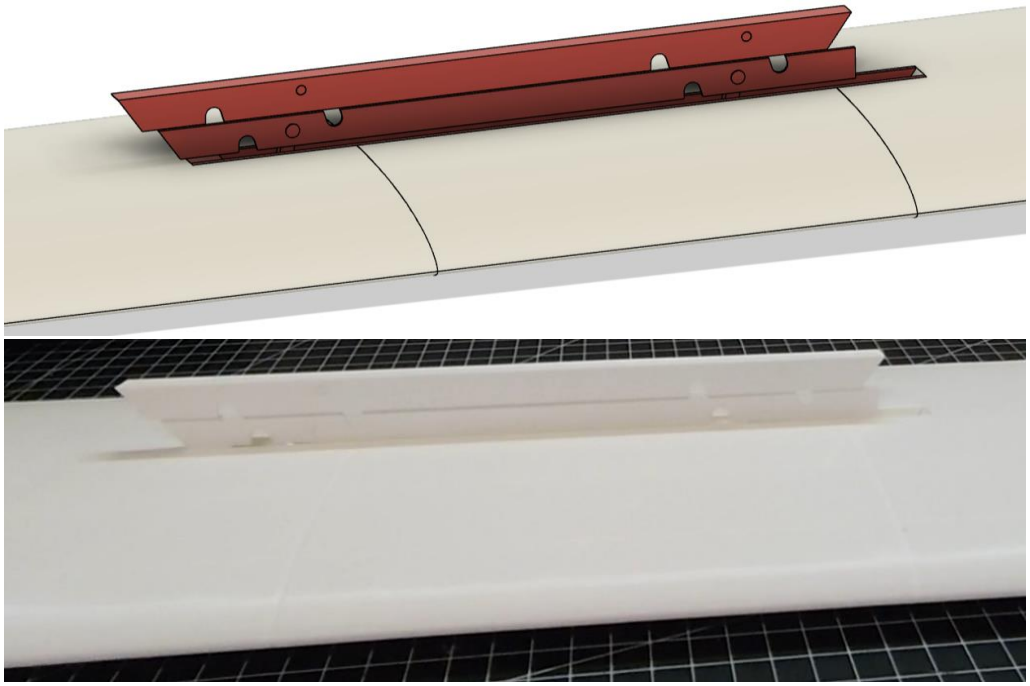


Figure 5: Spoiler introduced with v1.2. Design view (top) and realization (bottom)

Decal sheets

The package includes PDF files (600dpi resolution, letter and A4 format) to print the decals for the Pilatus B4. (Note: Colored PLA is used for the wing tips and horizontal stabilizer tips.)

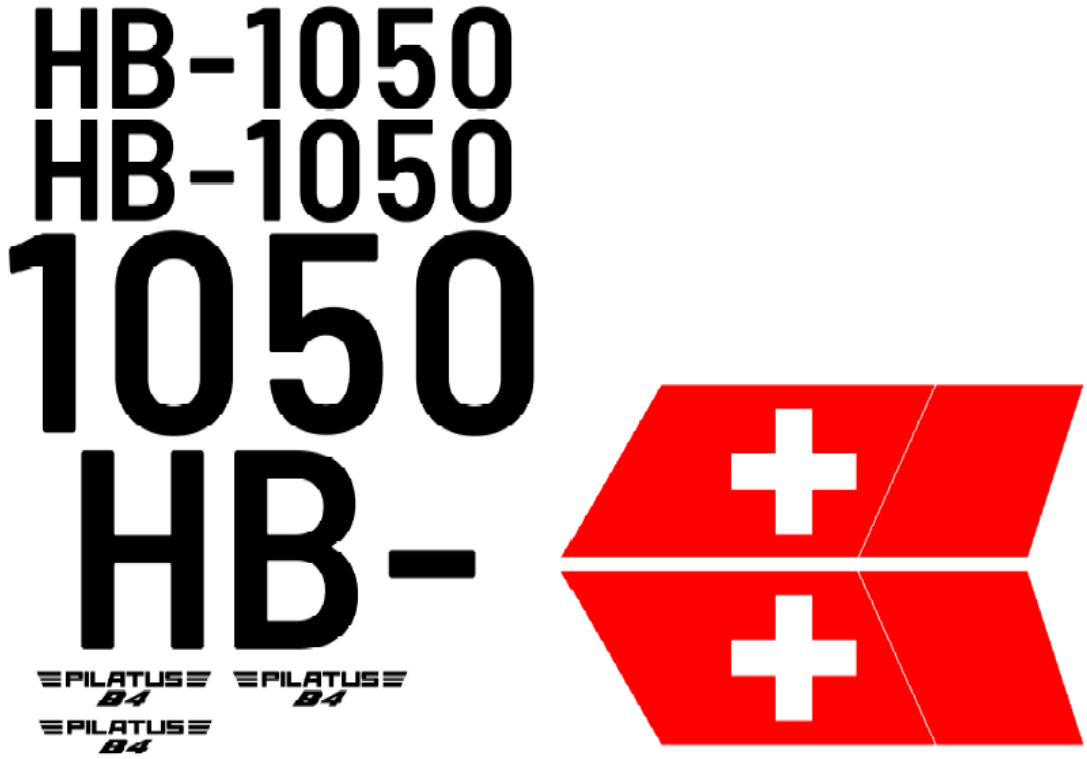


Figure 6: Decal sheets of the Pilatus B4

What you need

3D printer specification

All STL files have been successfully tested with my Prusa i3 MK3S.

3D print volume	Minimum requirement for single STL file (ensures printability of all plane parts): X=100mm; Y=140mm; Z=175mm. Requirement for provided gcode: X ≥ 200mm; Y ≥ 198mm; Z ≥ 175mm.
Nozzle diameter	0.4mm (for 100% scaling)
Filament support	PLA (TPU for optional wheel tires)

Required materials

Most plane parts are printable except for a few components such as carbon tubes or nylon screws.

Filament	White **PLA** for majority of print parts: ~900g (e.g., FormFutura Premium PLA Frosty White) Red **PLA** for wing/tail tip: ~10g (e.g., BASICFIL PLA Red or use paint instead) Transparent **PLA** for the canopy: ~20g (e.g., Fillamentum PLA Crystal Clear Iceland Blue) Optionally, black **TPU** for tires: ~10g, (e.g., 3D WarHorse TPU Black) Optionally, white **LW-PLA** for tail rudders: ~25g (e.g., colorFabb LW-PLA NATURAL)
Spring steel wires	Ø 1.0mm, 2x 1000mm (servo linkage rods) Ø 3.0mm, 1x 130mm (wing connector) Ø 6.0mm, 1x 280mm (wing connector) (Alternatively, Ø 8.0mm, 1x 240mm for even more stability.)
Self-tapping screws	8x M2.3x6mm (or similar) for wing servo cover 4x M2.5x8mm (or similar) for fuselage tip Optionally, 4x M2.3x6 mm (or similar) for wing servo holder
Nylon screws	2x M4x16mm
CA hinge sheet	1x e.g., Hobbyking CA Hinge Sheet 180mmx140mmx0.3mm
Magnets	2x 10x5x2mm for canopy (e.g., Magnetastico® Neodym Magnets)
Carbon fiber rods	Ø 2.0mm, 1x 375mm (horizontal stabilizer) Ø 2.0mm, 1x 232mm (vertical stabilizer) Ø 2.0mm, 1x 26mm (main wheel axle) Ø 2.0mm, 1x 15mm (tail wheel axle) Ø 1.5mm, 4x 900mm (fuselage) Ø 1.5mm, 8x 30mm (wing part connectors)
Carbon fiber pipes	Outer Ø 10mm, inner Ø 8mm, 2x 645mm (wing spar) Outer Ø 10mm, inner Ø 8mm, 1x 80mm (fuselage) Outer Ø 8mm, inner Ø 6mm, 2x 575mm (wing spar) Outer Ø 8mm, inner Ø 6mm, 2x 382mm (wing spar) Outer Ø 8mm, inner Ø 6mm, 1x 220mm (wing connector)
CA glue	Medium viscosity e.g., Hobbyking Super Glue CA (50g / 1.7oz) Medium
CA accelerator	Recommended e.g., Hobbyking Insta-Set CA Accelerator 2. Oz
Decal sheet	2x A4 or letter format (e.g., inkjet waterslide decal paper)
Clear spray coating	~200ml, for decal sheets (e.g., acrylic clear finish)

Radio control components

There is a huge variety of products available on the market that fulfills the requirements to provide enough power and precise control for the Pilatus B4". The following set is what I am currently using and can recommend. The engine-powered version provides a maximum thrust to weight ratio of 1.1 (according to ecalc.ch) and allows for an almost vertical climb rate reaching the visual limit within several seconds.

Glider version

RC control	4-5 channel TX/RX (optional tow hook requires 1 servo)
Servos	4-5x, Hobbyking Corona DS-843MG (recommended) or Hobbyking Corona DS-939MG (cheaper but less powerful and larger)
Battery 4.5-6V	Turnigy Receiver Pack 2/3A 1500mAh 6.0V NiMH
Tow hook (optional)	Outer Ø 8mm, e.g., TOPMODEL CZ Remote Tow Hook

Engine-powered version

RC control	5 channel TX/RX
Servos	4x, Hobbyking Corona DS-843MG (recommended) or Hobbyking Corona DS-939MG (cheaper but less powerful and larger)
Engine	Turnigy Aerodrive SK3 3536-1200kv
Axle extension	Direct coupling, e.g., Reely Navy direct coupling Spring steel wire Ø 5.0mm, 1x 39mm
Propeller adapter	e.g., Reisenauer clamp center hub 41/5,0/8
Folding propeller	10x6 ", e.g., Aeronaut CAM Carb. Z 10.0x 6.0"
ESC	Hobbyking Turnigy Plush-32 40A (2~6S) Brushless Speed Controller w/BEC
Battery	Hacker TopFuel LiPo 25C ECO-X 1800mAh 3S MTAG (155g, angle of ascent >60°) Hacker TopFuel LiPo 25C ECO-X 1800mAh 2S MTAG (105g, angle of ascent ~20°)

Assembly

Main video assembly guide

This Pilatus B4 assembly guide provides all required hints for a successful assembly of the Pilatus B4.

Chapters:

00:00 > Intro
00:23 > Preparation
01:38 > Fuselage
07:38 > Tail
11:34 > Wing
14:48 > Decals
16:15 > Radio control

Spoiler extension assembly guide

This spoiler extension assembly guide provides all required hints for a successful assembly of the spoiler. Left wing parts shown only.

Chapters:

00:00 > Intro
00:23 > Wing parts
01:34 > Spoiler
05:16 > Radio control

Pre-flight setting & check

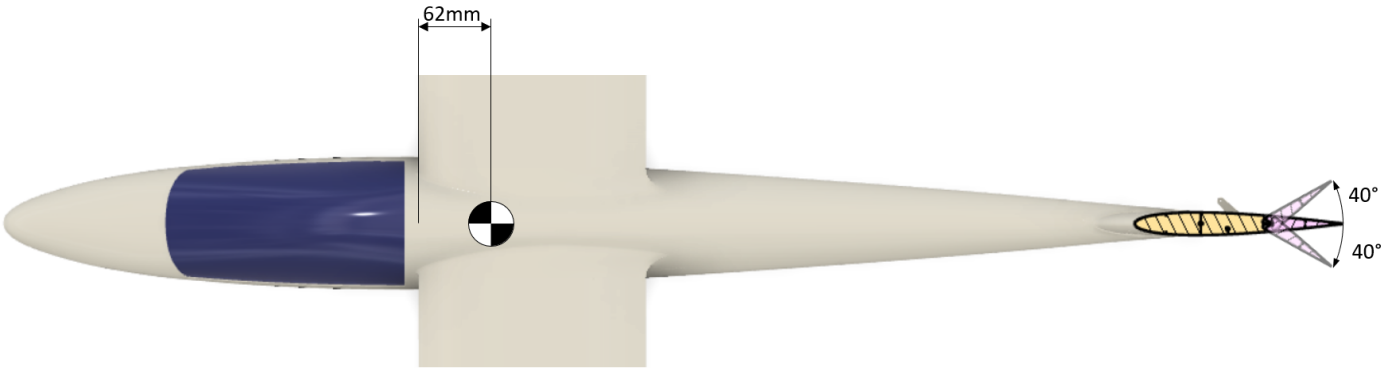


Figure 13: Center of gravity (CoG) and rudder deflection angles

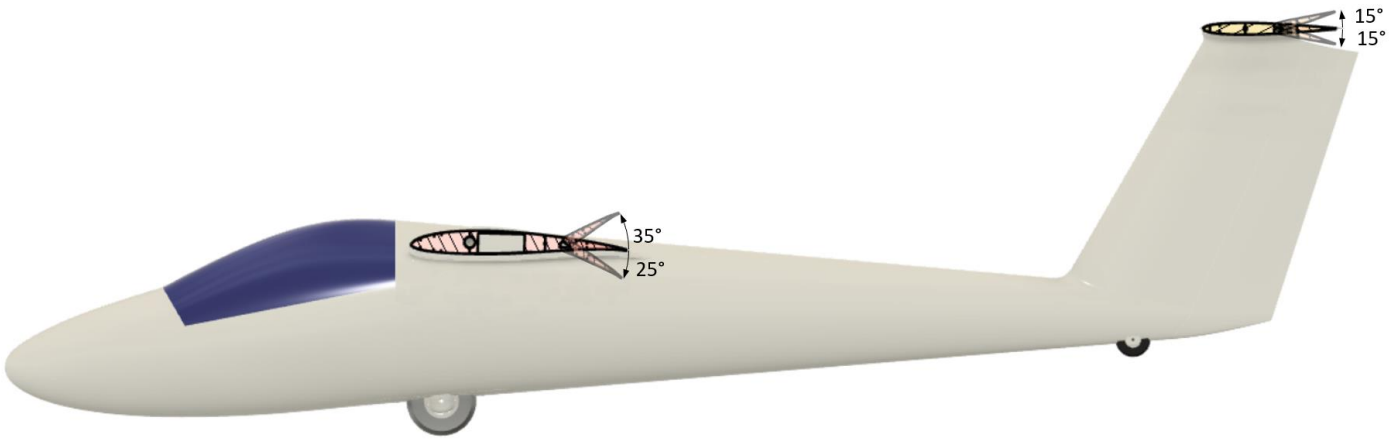


Figure 14: Aileron and elevator deflection angles

Track changes

Version 1.1

- Optimized inner structures to improve compatibility of the STL files with freely available slicer versions such as Ultimaker Cura 5.3.1 or PrusaSlicer 2.7.0. It is possible to rescale and print this airplane with other nozzle diameters. Correct downscaling of the original 3D print size to 60% could be confirmed with Ultimaker Cura and PrusaSlicer. Upscaling should be only limited by the print volume of your printer.

Parameter	Original 3D-print size	Smaller	Larger
Nozzle Ø:	0.4 mm (100%)	0.3 mm (75%)	0.5 mm (125%)
Scale:	1 : 6.5	1 : 8.67	1 : 5.2
Wingspan:	2308 mm	1731 mm	2885 mm
Length:	1011 mm	758 mm	1264 mm

- Moved from Ultimaker Cura to PrusaSlicer due to notably improved print quality of PrusaSlicer with my Prusa i3 MK3S. Latest slicer versions include a feature called “Arachne” which causes surface quality degradation for several parts of this model. Unfortunately, Ultimaker Cura does not allow to switch off this feature completely. On the other hand, PrusaSlicer allows to deactivate this option which I’ve used for all print parts except for the canopy. In summary, I recommend using PrusaSlicer 2.7.0 (tested) or later together with the newly created project files and optimized print settings.
- Optimized connection of inner wing parts. It now features a 3mm continuously overlapping outer perimeter to simplify alignment and gluing of the parts which also results in an improved surface finish.
- Improved rudder horn.
- Optimized placement of canopy hinges to improve print quality.
- Optimized placement of most out aileron hinges to improve print quality.
- Optimized wing servo recess to improve print quality.
- Changed filament recommendation for canopy from PETG to PLA. The Fillamentum PLA Crystal Clear Iceland Blue is easier to print and looks amazing.
- Created video of printed files to demonstrate the print quality. It is available on my YouTube channel.

Version 1.2

- Added optional spoilers to increase the descent during landing. They also represent a scale detail of the original Pilatus B4.
- Improved tires by replacing internal structure with gyroid infill.
- Partly replaced continuous brim by selective brim to reduce assembly time.
- Optimized print parameters with respect to print time and quality.