HELICES E-PROPS : BALANCING

The E-PROPS are known as ultra-light propellers, with a very low moment of inertia and very well balanced. Here below some explanations.

1. Why E-Props are particularly well-balanced ?

1.1 E-Props are ultra-light

E-Props are Carbon propellers with Titanium leading edge protection, designed and engineered to be as light as possible yet extremely strong.

E-Props 3-blade ground adjustable pitch for gear-drive engines up to 157 hp
weight = 2 kg / 4,4 lb

The lighter a propeller, the easier it is to get a good balance.

Rotax recommends a balancing tolerance of **0.5 g/m**.
At E-Props, we aim for a balancing tolerance of **0.2 g/m**, to avoid vibrations and ensure smooth, comfortable propeller operation.

On gear-drive engines like Rotax, the propellers are mounted on the gearbox flange. It is inevitable that the "gearbox bearing / gearbox shaft / eventual spacer between propeller and gearbox flange" assembly will have a slight form error.

gearbox shaft and flange - Rotax 9xx engines

Let's assume a form error of 0.1 mm (current value).

This will give :

- propeller weight = 2000 g => unbalance 0.2 g/m (acceptable to E-Props and within Rotax tolerance)
- propeller weight = 6000 g => unbalance 0.6 g/m (outside Rotax tolerance)
- propeller weight = 12,000 g => unbalance 1.2 g/m (well outside Rotax tolerance)

When the unbalance generated by shape defects is greater than 0.5 g/m, which is very often the case with E-Props' competitors, some propellers on the market require dynamic balancing of the propeller on the aircraft after each assembly/disassembly of the propeller (see § 3).

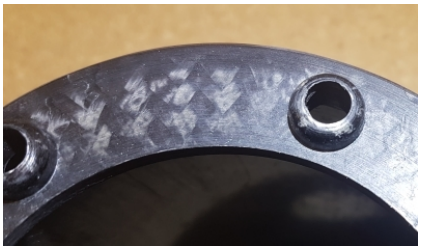
This is not the case with E-Props, whose light weight means they can easily withstand shape defects.

1.2 E-Props have integrated centering drive lugs

Competitors' propellers use steel centering drive lugs, which increase mounting dispersion (or centering / coaxiality error).

E-Props have carbon drive lugs integrated into the carbon spacer that mounts on the gearbox flange. In addition to saving 125 g, these carbon drive lugs reduce backlash and improve assembly precision, enabling excellent balance to be maintained.

Rotax centering drive lugs in steel
weight of the set = 125 g

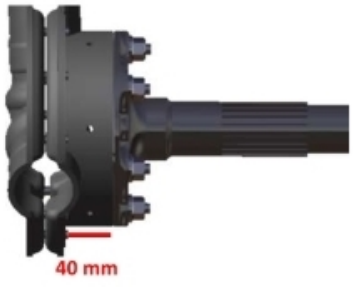


E-Props carbon drive lugs
integrated to the spacer

1.3 E-Props have an integrated spacer

Competing propellers use aluminum spacers which increase mounting dispersion (or centering / coaxiality error).

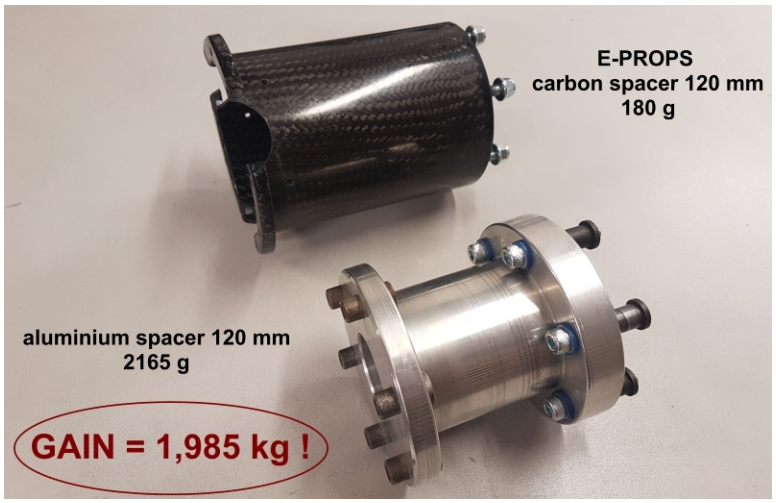
E-Props has developed an exclusive system to replace the usual aluminum spacers: integrated carbon spacers (ESU). They are ultra-light, 13 times lighter (!) than aluminum spacers, at 1.5 g/mm instead of 20 g/mm.



E-Props carbon spacer - length 40 mm

Example 1, for a 40 mm long spacer:
- the traditional aluminum model weighs 800 g
- the E-Props carbon spacer weighs only 60 g

Example 2, for a 120 mm long spacer:



The E-Props carbon spacer eliminates shape defects in spacer stacks, screw sets and centering drive lugs, making propeller balancing much easier.

1.4 E-Props are mass-produced

E-Props produces 75,000 carbon parts a year (in 2024).
Each blade model is mass-produced, so it's easy to have blades with a very close static moment to facilitate balancing.
Static moment : see § 2

1.5 All E-Props are balanced before shipment

Each propeller is carefully balanced by the E-Props team: blades + hub + spacer, on high-precision digital balancing benches designed and built in-house.

The computer system imposes a maximum tolerance of 0.2 g/m, and quality control must validate this value before authorizing shipment.

Ultra-light parts, ultra-low balancing tolerances and extremely precise assemblies result in perfectly balanced propellers that generate very little vibration.

And it really works: E-Props are known for their exceptional smoothness and comfort in flight. The many comments and feedback available on the e-props.fr website bear this out. 🙂

2. Balancing and static moment

In a propeller, the blades do not necessarily have the same weight.

What counts for perfect balancing is the distribution of mass along the entire length of the blade: the **static moment**. This is the sum of the products of the surfaces multiplied by the lever arm normal to the reference axis.

The weights P1 et P2 of each blade apply respectively to centre of gravity G1 and G2, which are not at an equal distance on the center of rotation O of the propeller.

The balancing must be realized to obtain : P1 x d1 = P2 x d2

The E-PROPS maximum static moment tolerance is 0,2 g/m

Report of weight and static moment measures (coming from E-PROPS software) :

Commande	Nserie	moule	diametre	masse MS	DATE_pesee	percage
[illegible]	43806	S63L	150	348.58 83.43	2018-10-08 08:18:38	6M8d75
[illegible]	48875	S63L	150	350.43 83.53	2018-10-08 08:18:21	6M8d75

This propeller is a 2-blade for a 40hp engine, diameter 150 cm.

- blade 1 weights 348,58 g and has a static moment of 83,43 g/m
- blade 2 weights 350,43 g and has a static moment of 83,53 g/m

By E-PROPS, the static moment tolerance is 0,2 g/m

=> here : the weights of the blades are different (gap 1,85 g), and the gap between the 2 static moments is 0,1 g/m. In the tolerance.

This propeller is perfectly balanced.

Each E-PROPS blade is identified with a serial number (example above 43806, 48875).
This number is written on the blade, and also in the RFID chip which is inside every blade (readable with a special RFID reader).

Each blade is balanced with an other blade (or other blades, if the propeller has more than 2 blades).
The obtained propeller is well-balanced. If you assemble non-paired blades, they would not be balanced together.

Please verify that the E-PROPS blades serial numbers are provided to go together.
This data is on your invoice, or delivery note, and if you do not have those documents, we can give this information to you. Please contact us by email.

In case of doubts, il is also possible to return the propeller to E-Props for balancing verification. Never fly with an E-PROPS propeller if the blades are not paired.

If you want to verify the balancing of your propeller yourself, make sure the assembly is correct : blades on the right side, align the holes properly.
It is possible that the propeller leans a litle : it is due to the 0,2 g/m tolerance. This tolerance has been calculated then deeply tested by our engineers.

=> Please note : those tests have been made on many motors; there are no vibrations up to 0,5 g/m (which is the Rotax tolerance).

3. Dynamic balancing

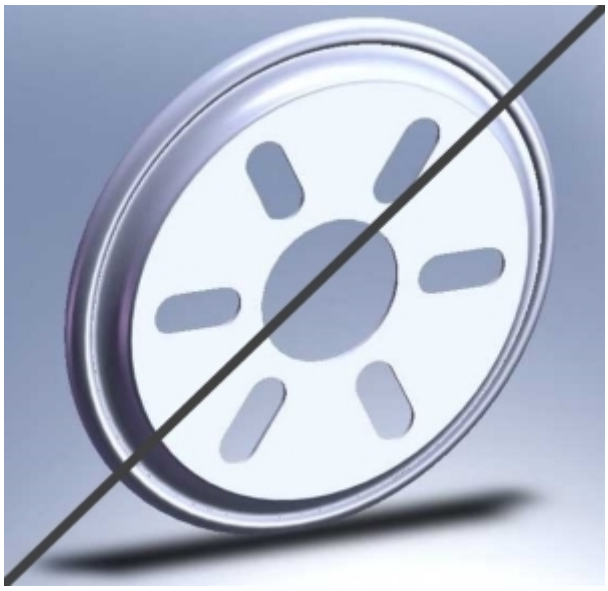
When vibrations are encountered, it may be thought that the propeller is not properly balanced. This is not necessarily due to the propeller alone, but to its positioning on the engine.

One can then be tempted to check if the balance of the propeller remains good on the engine during rotation (dynamic balancing).

The E-Props propellers being particularly light, the precision of the positioning of the propeller on the engine flange does not degrade the overall balance very little. Our team has tested the dynamic balancing of its models, without being able to measure any difference or make any improvement.

Since the 1940's, devices have been available to restore dynamic balancing of rotating propellers.

On a geometrically good engine and with a propeller well balanced in static, this type of device is useless (just expensive and heavy).
Moreover, it is essential to repeat this dynamic balancing of the propeller on the aircraft after each assembly/disassembly of the propeller.



dynamic balancing system = no need for E-Props, ultra-light and finely statically balanced

The very careful static balancing performed by E-Props in its workshops (blades and hub together) is sufficient to avoid vibrations. A dynamic balancing does not bring anything.