Integrated eVTOL propulsion units

Geared electric propulsion for advanced air mobility

The Application

The global advanced air mobility (AAM) market is projected to grow to over $1 trillion by 2040, powered by the rise of electric vertical take-off and landing (eVTOL) vehicles.

Driven by the convergence of advances in battery technology, electric motors, and autonomous flight systems, eVTOL aircraft are set to redefine urban and regional mobility – enabling on-demand air travel across cities, connecting underserved communities, and fundamentally changing the economics of short-range flight.

However, to meet the expectations for range, payload, noise, and reliability, eVTOLs require electric propulsion units operating at the extreme frontier of mass, efficiency, and power density.

The Challenge

eVTOL need propulsors that can support two very different flight phases:

1. A **cruise phase**, like a conventional aircraft – this requires a high-power propulsor operating at traditional propeller speeds of ~2,500rpm.
2. A **lift phase**, to enable vertical take-off and landing - this requires a high-torque propulsor capable of supporting large-diameter, low-speed propellers.

This causes a challenge when using traditional direct-drive electric motors because the only way to increase torque in a direct-drive motor of a given power rating is by increasing its thickness and mass.

This means that a system optimised for the lift phase will often be a significant source of drag – via greater cross-sectional area and mass – during the cruise phase. On the other hand, a system optimised for the cruise phase will struggle to provide enough torque for the lift phase. Inevitably, this has meant that eVTOL designers have needed to compromise in efficiency or performance in one or both phases of operations.

The challenge was clear: create a family of propulsors without these compromises. A set of solutions optimised for both the needs of the lift and cruise phases – and, in a tiltrotor configuration, capable of top-tier performance in both – while achieving mass, diameter, and efficiency targets that no previous solution had reached.

helix

The Solution

Helix partnered with Zoerkler, the leading provider of high-end transmissions, to develop a family of all-in-one electric propulsion units (EPUs) the transform the performance envelope available to the AAM market.

This new family of eVTOL EPUs integrate a Helix motor, with its world-class power density, with a Zoerkler reducer transmission that can turn this power into torque at record efficiencies.

- When deployed in a **cruise configuration**, the Helix-Zoerkler EPU can provide peak output of 400kW via the Helix motor – with a steady-state output of 250kW.
- When deployed in a **lift configuration**, the Helix-Zoerkler EPU uses the Zoerkler transmission to produce up to 1,600Nm of torque below 1,000rpm – without the mass or diameter associated with traditional direct drive solutions.

The Results

Compared to a traditional direct-drive propulsor needed for the lift phase, the Helix-Zoerkler EPU is 50% narrower and achieves significant mass savings. Thanks to Zoerkler's transmission technology, this is all achieved at a 98% efficiency level – making this EPU solution a true zero-compromise offering for eVTOL propulsion.

As a result of reduced diameter and mass of this EPU family, eVTOLs can significantly increase their range or payload. By also integrated oil pumps, active cooling, and bearing systems, the EPU family configuration is engineered to serve as a compact, self-contained architecture that is both easy to deploy while also supporting the custom adaptation required by airframe makers and certification authorities.