Fraunhofer IISB

Fraunhofer Institute for Integrated Systems and Device Technology IISB



# Highly Integrated and Fault-Tolerant Actuator

## For Next Generation Electric Aircraft Door

Actuator for electric door-opening.
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### Motivation

- The doors are a critical component of modern passenger aircraft. Due to safety requirements, it is essential that the door can be opened even in the event of an aircraft crash or other emergencies. [1]
- Even though the initial cost of an electrified aircraft door is higher than that of a traditional manual door, it offers a wider range of functions, such as effortless opening, a defined opening cycle time, and autonomous cabin operation with reduced flight crew. [1]
- The project is part of the LuFo VI-2 project DIMENSION, which was funded by the *German Federal Ministry of Economic Affairs and Energy BMWE*. Together with the project partners *Fraunhofer ICT* (plastic housing), *Wittenstein* (gearbox) and *Airbus* and *Airbus Heli-copters* (system requirements), the Fraunhofer IISB designed, manufactured and validated a highly integrated and fault-tolerant drive system for an electric door actuator.

Supported by:

Federal Ministry for Economic Affairs and Energy

on the basis of a decision by the German Bundestag

## Features

**Compact and lightweight actuator:**

- High mechatronic integration
- Plastic housing
- Cylindric inverter design for ideal utilization of installation space

**Fault-tolerant drive:**

- 2 × 3 phase permanent magnet synchronous machine with low magnetic coupling
- 6 phase inverter
- Individual gate drivers
- Separated DC link
- Thermal fuse to prevent fire inside the door
- Temperature sensors in the motor winding and near the semiconductors

→ Emergency opening possible even if three phases fail

**High-efficient drive:**

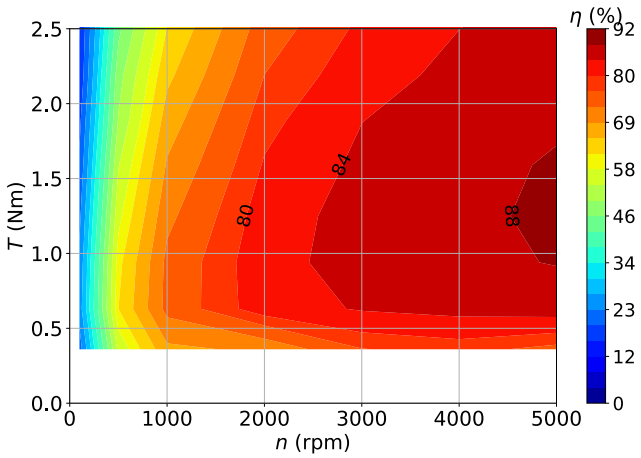
- Measured motor efficiency > 90 %
- Measured inverter efficiency > 97 %
- Included EMI filter

## Physical

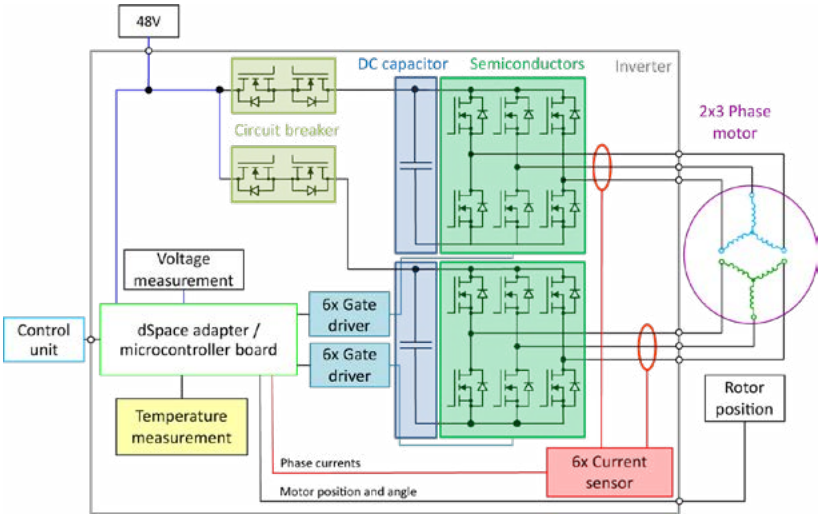
- Actuator torque: up to 500 Nm
- Gear ratio: 350
- Motor power: 1.1 kW
- DC voltage: 48 V
- Switching frequency: 20 kHz
- Actuator weight: 2.7 kg
- Actuator dimension: D 84 mm × L 215 mm

## 1.1 kW Dual-Three Phase Permanent Magnet Synchronous Machine and Redundant Inverter

The Fraunhofer IISB presents a highly integrated and fault-tolerant actuator for an electric door application in future aircraft. The drive system consists of a redundant inverter, and a dual-three phase permanent magnet synchronous machine. The inverter consists of two separated three phase inverters with individual DC link capacitors. In case of a short circuit in the inverter or the motor, the circuit breaker automatically turns off the corresponding faulty three phase subsystem. The remaining healthy three phase system can still perform an emergency opening without overheating. The motor has a concentrated single-tooth winding, which reduces the axial winding head and the magnetic coupling between the phases. This enables easier motor control in the event of a failure of a three-phase system. [1]




Measured efficiency of the drive (motor + inverter).
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System architecture of the redundant drive unit.
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[1] D. Walch, M. Renner, C. Bentheimer, A. Schröder, *„Highly Integrated and Fault-Tolerant Actuator for Next Generation Electric Aircraft Doors"*, in 2nd Production Technologies and Systems for E-Mobility (EPTS). IEEE, 2025

**Contact**

Christian Bentheimer
Group Manager Aviation Electronics and H2 Systems
Tel. +49 9131 761-581
christian.bentheimer@iisb.fraunhofer.de

Fraunhofer IISB
Schottkystraße 10
91058 Erlangen, Germany
www.iisb.fraunhofer.de