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THE WORLD'S FIRST FULLY ELECTRIC AEROBATIC AIRPLANE

- Battery management system and monitoring tool for airborne systems -

Aerobatic airplanes have a very high power demand, which means that such airplanes consume a lot of fuel for propulsion, which itself makes aerobatic flying very noisy. Because of the high settlement density in Switzerland, aerobatic flights are the source of many complaints and are therefore constrained by the government. The higher maintenance costs and increasing fuel prices incites a change towards alternative propulsion systems.

Because of these reasons, the evolaris project was initiated in February 2015. An electric aerobatic flight does not only satisfy the pilot's activity, it also improves routine and aeronautical skills. With this in mind, the aim of this project is to develop the world's first electrically driven aerobatic airplane to demonstrate the possibilities of an electric propulsion unit and also to find technical solutions to future electric mobility systems, where a high battery power demand is needed.

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Project evolaris

This work is about developing a new concept and its implementation for a battery management system (BMS) which is used in aerobatic airplanes. The main goal is to design the BMS along aircraft standard practices and the main focus is on functional safety.
The development of requirements capture, safety concept and hardware implementation was accomplished at the ESReC (BFH) in Biel.
Finally, the developed hardware has been verified by a measurement under real conditions.

Battery management system (BMS)

The main goal was to develop a functionally safe BMS which mainly monitors the cells. The BMS had to be able to detect any failure – without causing a motor or system shut-down.
The safety concept is based on the fact that the pilot is the last instance who is able to shut-down the battery.
Therefore, delivering reliable information about the battery's condition (state of charge, state of function) to the pilot is essential.

The main goals to be fulfilled were:

- Monitoring of each single cell
- Redundant non-software reliant feedback
- Follow the ASTM F2840 Design
- Cell balancing algorithm
- Overcharge protection

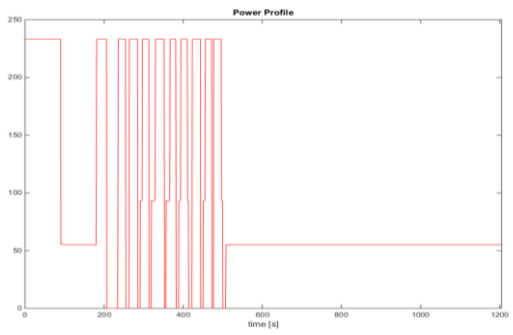
The work was divided into:

- Safety and risk analysis
- Evaluation of suitable battery cell technology
- Draft and detailed design of the BMS hardware
- Implementation of the final hardware
- Design and implementation of a monitoring tool on the PC

Cell evaluation

The requirements for the battery cell are:

- Save and reliable; for aerospace applications
- High power density (1500W/kg)
- High energy density (>150 Wh/kg)
- Low power dissipation

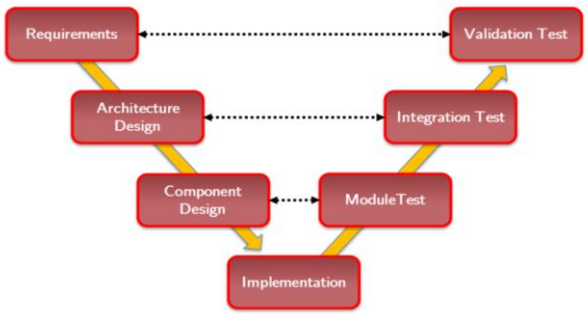


Together with MSW Aviation a power profile representing a typical power load during an aerobatic flight program was developed. All cells were tested according to this profile at different temperatures.

Development process

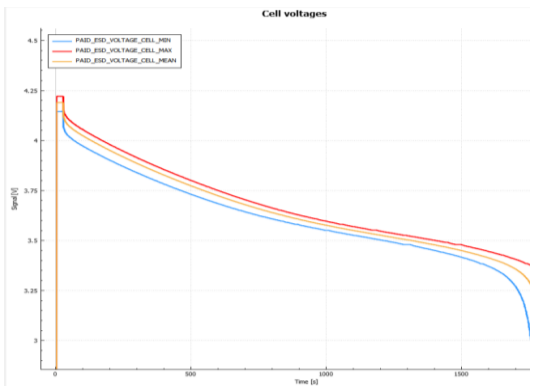
All hardware and software components are developed according to the V-modell, which is widely used for developing hardware and software in the industry.

At Bern University of Applied Sciences the V-model is used for general hardware projects too.



Monitoring tool

The main purpose of this tool is to act as a terminal and to visualize all data generated by the BMS. Thus, the basic idea is to visualize the single CAN messages and display the correct value incl. unit on the pilot's screen. Additionally, the monitoring tool is able to log and save all incoming messages in their timing-order. Also, a saved log-file can be reloaded.



Conclusion

80% of all critical functions of the BMS have been successfully tested and verified. Before the maiden flight takes place, all additional relevant battery and system functions will additionally be tested. Here, the battery will undergo further electrical and mechanical stress tests.

Furthermore, the developed BMS represents a universal platform which can be easily adapted to other projects where functional safety is a crucial point.

References

Partners

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
BAZL Bundesamt für Zivilluftfahrt
OFAC Office fédéral de l'aviation civile
UFAC Ufficio federale dell'aviazione civile

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