

BATTERY SYSTEM

Developed for electric vehicle

Fraunhofer IISB participated in the European AVTR project that has addressed the powertrain systems for light EVs (electric vehicle). The IISB was responsible for the entire battery system of an EV.



High energy-density automotive battery module with cost-optimized battery monitoring (Photo: Fraunhofer)

IN THE ELECTRIC VEHICLE, FRAUNHOFER IISB (Germany) has integrated a battery management system comprising control algorithms. The international [AVTR project](#) focused on a special EV that may fulfill the Japanese [Kei Car specification](#). According to Fraunhofer, in the vehicle developed within the AVTR-project, modularity, low costs, and reduced complexity were implemented, as well as high-end Italian product design.

In general, the Fraunhofer IISB Battery System Group focuses on innovative mechanical and thermal design of battery modules and systems including the related battery management system (BMS) with battery monitoring and the according battery models. The project has addressed the development and the industrialization of complete powertrain systems for light electric vehicles. In contrast to already available EVs, the international project consortium focused on a special electric vehicle that may fulfill the Japanese Kei-Car specification. The

vehicle, developed by the Italian companies IFEVS and Polimodel, strictly follows four main objectives: low cost, modularity, producibility, and high-end Italian product design.

The vehicle is designed with a total length of approximately 3 m, thus making the vehicle ideal for crowded inner-cities. Being part of the international consortium, Fraunhofer IISB was responsible for the novel fully redundant battery system. The main objectives were attributed to the battery system, its battery management system, and battery monitoring.

Battery cells

The battery modules were designed in cooperation with the [Draexlmaier Group](#) and manufactured by them. Modularity and independence of the battery cell manufacturer was achieved by using automotive grade 3 Ah cylindrical [lithium-ion](#) battery cells of type 18650 from an Asian battery manufacturer. According to Fraunhofer, type 18650 battery cells are in highest mass production for years now, thus providing lowest costs, low manufacturing tolerances, and are available from most premium cell manufacturers. The eight battery modules provide 12 kWh of energy to the 15 kW powertrain (30 kW peak power). The modules use a 20p7s cell configuration and bring a weight of 9,4 kg, thus providing a gravimetric energy density on battery module level (i.e., with electronics included) as high as 160 Wh/kg.

Furthermore, battery monitoring placed on battery modules followed the same objectives. Battery monitoring was optimized for lowest size and bill of materials. The PCB size could be reduced to 47 cm², still providing voltage measurement accuracy, temperature sensing and passive balancing. The small size could be realized by using a highly integrated state-of-the-art battery monitoring IC with voltage measurement accuracy. [Panasonic](#) developed and provided novel prototypes of Mosfets including protective elements for passive battery cell balancing. By using these novel Mosfets, the bill of materials can be reduced with positive effects on costs and reliability.



Kei Car electric vehicle prototype designed and assembled by IFEVS-Polimodel (Photo: Fraunhofer)

CAN network included

Finally, an advanced battery management system developed by Fraunhofer IISB and based on an [Infineon](#) 32-bit microcontroller running an automotive OSEK / Autosar operating system was adapted to the needs of the AVTR project and integrated into the battery system. The BMS (battery management system) comprises control algorithms (e.g., power contactor control), data communication via a CAN network, and safety mechanisms for protecting the battery system. This BMS was integrated into both battery systems and configured to work as independent systems. As full redundancy was implemented, the driver of the EV is able to check the state of every battery system on the dashboard and even driving with only one axle is possible at any time.

Fraunhofer says, with the vehicle developed within the AVTR project, modularity besides low costs and reduced complexity were implemented and shown for the first time together with an Italian car design. According to the company, the shown concepts and prototypes prove the feasibility of a light full electric vehicle with reduced complexity, reduced costs and improved modularity. This development may lead to affordable EVs, thus increasing the attractiveness of EVs for the mass market.

The final presentation of the vehicle prototype took place during the unique [Parco Valentino car show](#) in June 2015 in Turin, Italy.