

Fully Digital Electronics for the Dolphin E-Bike

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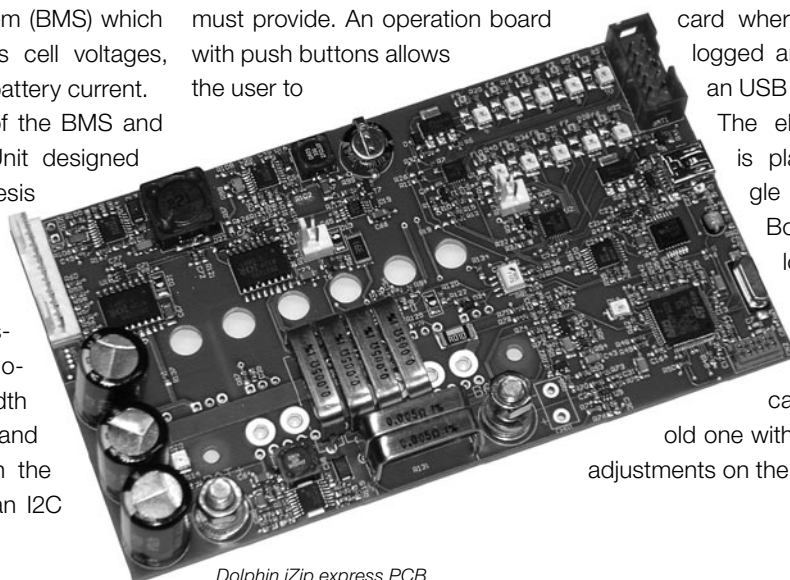
E-Bikes are experiencing an increase in popularity. The combination of human and electric power allows higher speed and a bigger range. The Dolphin iZip express, best rated in the E-Bike test of the consumer magazine "Kassensturz", has been sold successfully in Switzerland for several years. Developer Dolphin E-Bikes GmbH has now found a distribution partner in the USA. The E-Bike company iZip has agreed to finance a redesign of the Dolphin iZip express. The aim of our Bachelor-Thesis was to design a fully digital battery management system and motor controller unit.



The E-Bike on the test bench

In a previous collaboration between the Laboratory for Industrial Electronics and Dolphin E-Bikes GmbH the Nickel Cadmium battery pack was replaced by a Lithium Ion pack. Lithium Ion batteries need a Battery Management System (BMS) which constantly monitors cell voltages, temperatures and battery current. The new solution of the BMS and Motor Controller Unit designed in this Bachelor-Thesis is based on an ARM processor of the new Cortex M3 family. The processor controls the Motor with a pulse width modulated signal and communicates with the BMS device over an I2C

serial bus. Furthermore, it measures the pedal frequency with a tachometer and the driving speed with a speed sensor placed on the back wheel of the bike to calculate the amount of support the motor must provide. An operation board with push buttons allows the user to



Dolphin iZip express PCB

choose between five different power levels. Multifunctional LEDs on the board indicate the charge of the battery and show the selected power level. The bicycle lights are turned on automatically by the processor measuring the ambient brightness. However, the light can be turned on manually over the operation board.

To ensure the safety of the cyclist several security measures have been implemented: The batteries are protected from overheating and overcharging by the BMS and in a load overcurrent situation the motor is turned off immediately by a security circuit that works independently from the processor. If the motor can't be turned off properly a secondary security circuit shuts down the whole system.

For long term performance evaluation and maintenance support the hardware contains a microSD card where data can be logged and read out by an USB interface.

The electronic circuit is placed on a single Printed Circuit Board (PCB). It follows all specifications to make sure that the new system can replace the old one without the need of adjustments on the bike.

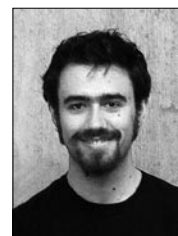


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