18A Solar Water Pump Inverter Design

Subject: Automation and Control
Thesis advisor: Prof. Dr. Andrea Vezzini
Experts: Peter Baumann (drivetek ag)
Project partner: ennos gmbh, Biel

Within the scope of this bachelor thesis, the prototype of a power inverter was developed to drive specially designed permanent magnet motors powered by a set of solar modules. Inverter and motor are intended for use in electric pumps for land irrigation, drinking water supply and saline water removal at salt productions in developing countries. Hence an important aspect of the development was, besides the technical challenge, to optimize the design for low batch production cost.

The prototype development encompassed circuit design, simulation, PCB layout, prototype manufacturing, software development and testing.

Hardware Design

Dimensioning of the three MOSFET half-bridges, their respective gate drivers and analog measurement circuitry were a keypoint in power electronics circuit design and layout. Since the motor will be powered by solar modules, the inverter must handle DC bus voltages ranging from 28 V up to 100 V and input currents up to 18 A to enable maximum power point tracking up to 960 W.

Software Development

On the microcontroller side, software development based on Texas Instrument's InstaSPIN FOC™ solution was required. InstaSPIN FOC™ is used to commutate electric motors without the need of rotor position sensing. The closed-source core component of this software package, running in ROM of selected Piccolo microcontrollers, is called FAST (**F**lux **A**ngle **S**peed **T**orque) observer. It estimates the rotor flux angle of the driven motor by hardware provided phase voltage and current feedback. Example code of an evaluation kit was used as framework to create the target application. Adapting the code included configuration of the PWM frequency, dead-band delay for the given MOSFET half bridges, A/D conversion timing and insertion of motor data for the observer. As the inverter shall draw the maximum power out of the connected set of solar modules, a maximum power point tracking (MPPT) algorithm was developed but not yet implemented in the target application. It's effectiveness was tested by simulation. Further, the use of a real time OS was clarified and implementation recommendations for further software development were proposed.

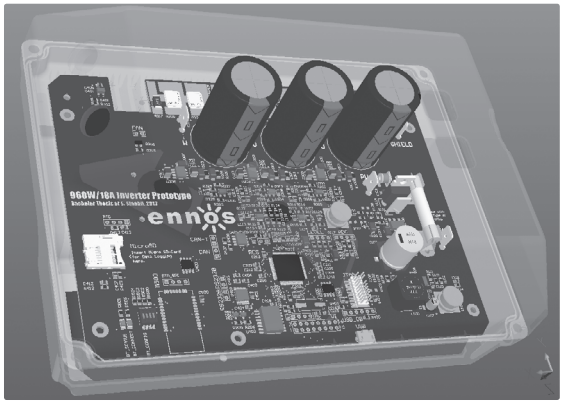
Stefan Stähli

Prototype Manufacturing

Prototype PCBs were manufactured at a PCB supplier and populated manually at HuCE Microlab/BFH in Biel. First experiences for batch production, like reflow soldering temperature profiles and handling of different special surface mounted devices was gained.

Work Progress and Perspective

Due to some prototype reworking difficulties after destructive test runs, the capability of the achieved design could not be fully proofed. Nonetheless, the resulting design, put into practice by two still functional pieces of hardware, builds the cornerstone for continuative testing, software development and in the medium term, batch production proof design.



960W/18A Solar Water Pump Inverter