Press Release

Filling the Tank Efficiently with the Sun

Fraunhofer ISE Develops a Compact Charger with 97% Efficiency for Electric Vehicles

According to the energy plans of the German federal government, by 2020 there should be one million electric cars on German roads, while at the same time 35% of its electricity should be from renewable energy sources. For the storage of fluctuating solar and wind power, electric vehicles will play an important role in the intelligent grid of the future. Researchers at the Fraunhofer Institute for Solar Energy Systems ISE have developed a three-phase charger with 97% efficiency and high power density, to be used in charging stations and in vehicles. With a rated power of 22 kW, the charger is able to load a typical electric vehicle battery to 80% in 45 minutes.

Through the use of novel silicon carbide transistors (SiC JFETs), which are characterised by low conduction losses and good switching performance, the Freiburg researchers achieved a maximum efficiency of over 97%. Special semiconductor modules and gate driver circuits were developed and optimised specifically for the charger. The new semiconductor technology enables a switching frequency of 80 kHz. This significantly reduces the size of the filters on the side of the grid and battery which enabled a power density of 2.8 kW / l to be achieved for the complete converter. This extremely compact charger, inclusive of all filter chokes and heat sink, measures just 340 x 230 x 100 mm^3. By comparison, commercially available chargers for electric vehicles achieve efficiencies of around 90%, are usually single phase, have a maximum power of only 3.3 kW and a power density in the range of 0.5 kW / l.

Fraunhofer Institute for Solar Energy Systems ISE
Heidenhofstr. 2
79110 Freiburg
Germany
Press and Public Relations
Karin Schneider
Phone +49 761 4588-5150
Fax +49 761 4588-9342
info@ise.fraunhofer.de

www.ise.fraunhofer.de

The high switching frequency poses a major challenge for the digital controllers. Therefore, a new controller board was specifically developed for the charger at Fraunhofer ISE. This is capable of measuring currents and voltages in high resolution with a sampling frequency of 80 kHz, running the digital controllers and generating the pulse-width modulated signals for the semiconductor switches.

The charger is a two stage converter. The first stage converts the three phase grid voltage of 400 V_{AC} into a DC voltage. A DC/DC converter is used as the second stage in order to adjust for the varying battery voltage of 300 - 500 V_{DC}. To save weight, volume and cost while increasing the efficiency, a transformerless circuit topology with extra electrical safety measures, was used.

The charger is bidirectional and is thus not only able to take energy from the grid for charging, but also to feed the energy stored in the battery back into the grid. This enables energy from fluctuating renewable energy sources, such as wind and solar, to be stored in the battery during times of high availability and to be fed back into the grid at times of high grid load and/or reduced renewable energy availability. Electric mobility thus provides the opportunity for the batteries in the vehicles to be used as energy storage for the grid. Of particular interest is the large cumulative output of bidirectional battery chargers, making it possible to compensate for short-term power and frequency fluctuations in the power grid.

The new development was part of the joint project, Fraunhofer Systems Research Electric Mobility, funded by the German Federal Ministry of Education and Research (BMBF) and involving more than 30 Fraunhofer institutes.

Fraunhofer Institute for
Solar Energy Systems ISE
Heidenhofstr. 2
79110 Freiburg
Germany
Press and Public Relations
Karin Schneider
Phone +49 761 4588-5150
Fax +49 761 4588-9342
info@ise.fraunhofer.de

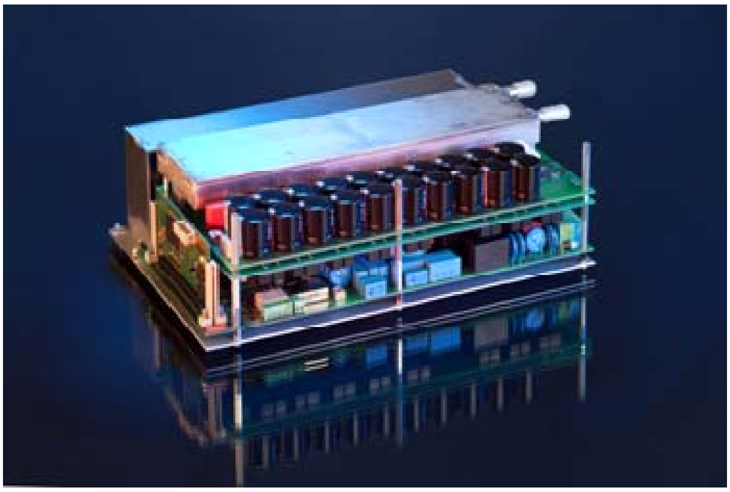
www.ise.fraunhofer.de

Information material:
Fraunhofer ISE, Press and Public Relations
Phone +49 761 4588-5150
Fax +49 761 4588-9342
info@ise.fraunhofer.de

Text of the PR and photos can be downloaded from our web page: www.ise.fraunhofer.de

Contact person for further information:
Prof. Dr. Bruno Burger, Fraunhofer ISE
Telefon +49 761 4588-5237
bruno.burger@ise.fraunhofer.de

Dipl.-Ing. Stefan Reichert, Fraunhofer ISE
Telefon +49 761 4588-5476
stefan.reichert@ise.fraunhofer.de

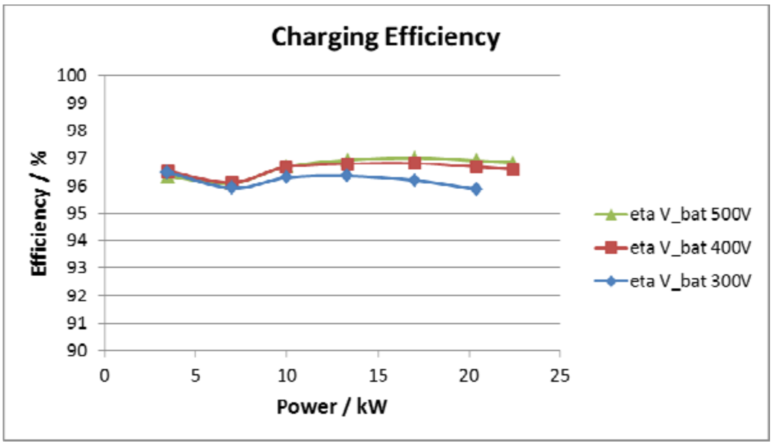


The Fraunhofer ISE developed three-phase, 22 kW, bidirectional charger.
©Fraunhofer ISE

Fraunhofer Institute for
Solar Energy Systems ISE
Heidenhofstr. 2
79110 Freiburg
Germany
Press and Public Relations
Karin Schneider
Phone +49 761 4588-5150
Fax +49 761 4588-9342
info@ise.fraunhofer.de

www.ise.fraunhofer.de

Press Release



Measured efficiency of the complete charger with a maximum efficiency of over 97% at a power of 17 kW and a battery voltage of 500V. ©Fraunhofer ISE

Fraunhofer Institute for Solar Energy Systems ISE
Heidenhofstr. 2
79110 Freiburg
Germany
Press and Public Relations
Karin Schneider
Phone +49 761 4588-5150
Fax +49 761 4588-9342
info@ise.fraunhofer.de

www.ise.fraunhofer.de