Low Cost Lithium-Ion Battery Charger for Automotive and Renewable Energy Applications

IEEE International Future Energy Challenge
IFEC Topic A

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IEEE POWER ELECTRONICS SOCIETY
Powering a Sustainable Future

Topic A – List of Accepted Teams

Rank	University	Country	# Students	Advisor	Advisor email
1	Virginia Polytechnic Institute and State University	US	9	Dr. Kathleen Meehan	kameehan@vt.edu
2	Huazhong University of Science & Technology	China	7	Prof. Yong Kang	ykang@mail.hust.edu.cn
3	University of Kassel	Germany	5	Prof. Dr.-Ing.habil. Peter Zacharias	peter.zacharias@uni-kassel.de
4	University of Connecticut	US	5	Sung Yeul Park	supark@engr.uconn.edu

Topic A – List of Proposals

	University	Country	Students	Advisor	Advisor email
5	Seoul National University of Science & Technology	Korea	16	Sewan Choi	schoi@seoultech.ac.kr
6	National Taiwan University of Science and Technology	Taiwan	6	Prof. Huang-Jen Chiu	hjchiu@mail.ntust.edu.tw
7	UNIVERSITY OF PERADENIYA	SRI LANKA	4	Dr.S G.Abeyrathne	sunil@ee.pdn.ac.lk
8	Indian Institute of Technology	India	4	Prof Vivek Agarwal	agarwal@ee.iitb.ac.in

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Competition Date and Location

- July 20-22, 2011

- Institute of Advanced Vehicle Systems
  University of Michigan – Dearborn
  4901 Evergreen Road
  Dearborn, MI 48128

- Travel Gateway: Metro Detroit Airport (DTW)

Judging Team:

- Experts from IEEE Power Electronics Society and other Societies
- Representatives from manufacturers, national labs, independent test labs, utilities, and R&D engineers
- Engineering Professors

Judging Criterion

- Cost effectiveness
- Performance
- Quality of the prototype and other results
- Practicality
- Engineering reports
- Adherence to rules and deadlines
- Innovation
- Future promise

Objective

- To encourage the development of the low cost lithium ion battery charger systems for vehicle and other lower power applications.
- To encourage the use of green vehicle (EV, HEV, and PHEV) systems.
- To effectively integrate the theoretical and practical aspects of battery and corresponding electronics education with innovative experiments and design projects.
- To promote practicality and affordability into the low cost design target improving the system performance.
- To foster practical learning and hands on experience with the problem solving skills through the team based development.

Project Goals

- Develop a unidirectional 3kW (maximum capacity) lithium-ion battery charger for electric vehicles and other energy conversion systems.
  - Achieve maximum energy transfer.
  - Optimize the state of charge without overcharging and over di/dt which can damage batteries.
  - Be a leading edge solution in the areas of performance, reliability, and safety.
  - Design to minimize power density and component cost and count (consider packaging) while satisfying performance requirement.
  - Run the system safely under various operating conditions employing protections for over current/ temperature, over charging, and power failure.

General Requirements

- The battery charging system needs to be designed using a microprocessor based on a digital control system which has capability to minimize the size of control board.
- The system must have circuit protection capable of handling over current, over charge/discharge, over temperature and power failure. The lithium-ion battery charger needs to monitor temperature for safety.
- A method called “Constant Current Constant Voltage” (CCCV) is often used for charging of lithium-ion batteries to avoid over charging. For the Challenge, advanced fast charging and cell balancing method will receive bonus points.
- Comply with all relevant IEC and IEEE standards.
- Design to suit minimum cost for high volume manufactures.

Charger Specs

- Input: 110V and 220V dual input capability
- Output voltage: nominal 365V, range 0 to 500V
- Output power: >3kW at nominal voltage
- Power factor: >0.98 (a power factor correction stage should be included in the design)
- Efficiency: >0.96 at nominal output
- Communication: CAN protocol preferred
- User interface: the charger shall include a user interface keyboard

Battery Specs

- Nominal voltage 332V
- Cut off voltage: 250V
- Maximum charge voltage: 370V
- Absolute maximum voltage: 410V
- Capacity: 30Ah
- Nominal Energy: 11kWh
- Maximum discharge rate: 4C
- Maximum charge rate: 4C
- Continuous charge rate: C/2
- Trickle charge: C/5
- Operating temperature: -10 to 60C

Competitive Requirements

- Cost effectiveness
- Novelty of solutions
- Higher performance
- Lower weight
- Faster charging
- Longer battery effective usage times,
- Consistent reliability

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Keep in Mind

- Key is to have a working prototype
- Bonus points given to novelty

Competition Details

- Review of design
- Review of self test reports
- Review of prototype
- Review of functionality
- Prototype charging demonstration
- 110V and 220V 60Hz supply will be made available
- 11kW, 360V lithium ion battery will be made available for testing

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Alternative Plan for Topic Testing

- In case lithium ion battery is not available, a lead acid battery pack will be provided as a test platform which provide the same voltage and Ah for the testing during competition
- Resistive or electronic loads for general power rating testing