

Load Dump Analysis in a 42/14V DC-DC Converter for Automotive Applications

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Abstract

The paper presents a model for a dc-dc centralised based architecture using Matlab/Simulink for load dump analysis. As the electrical load varies for various driving conditions such as day or night, summer or winter; and city or country side, the analysis of load change is a very important parameter for system behaviour. In order to study the 42V power generation dynamic performance under load variations, step change in loads have been investigated. A detailed mathematical model for a 3-phase, 4 kW and 42V Lundell alternator average electrical equivalent circuit along with the DC/DC converter based architectures for dual-voltage systems has been covered in previous publications. Aspects of the steady-state output current capabilities, transient behaviour due to load dump on the 14/42V buses and the behaviour of the system model under different loads are assessed and results discussed. The performance of the 42V Lundell alternator with the interleaved six-phase buck dc-to-dc converter system is modelled using Simulink software to assess the effectiveness of the model and its transient behaviour. The simulated results are presented for the transient characteristics of the system for load dumps.

Keywords: 42V PowerNet, automotive, DC-DC converters, dual system, load dump, transient.

References

- [1] "Results of the review of the Community Strategy to reduce CO₂ emissions from passenger cars and light-commercial vehicles," European commission, Brussels, July 2007.
- [2] White paper on transport, "Roadmap to a single European transport area -Towards a competitive and RESOURCE EFFICIENT transport system," European Commission, Brussels, 2011.
- [3] "Special Euro-barometer 372, Climate Change", European Commission, Oct. 2011.
- [4] M. Shrud, A. Bousbaine, R.Thorn, "42V Power System Architecture Development," The 3rd IET Conference on Automotive Electronics, The University of Warwick, Coventry, UK, June 2007.
- [5] M. Shrud., A. Bousbaine, A. Elazreg and N. Benamrouche, "Analysis and Simulation of a 42V Power System for Automotive Applications," The 44th International Universities' Power Engineering Conference, Glasgow, Scotland, UK, 1-4 Sep. 2009.
- [6] J.G. Kassakian, D.J. Perreault, "The future of electronics in automobiles," in Proceedings of the 13 the International Symposium on Power Semiconductor Devices and ICs, pp. 15-19, 2001.
- [7] J.G.W. West, "Powering up - a higher system voltage for cars," IEE Review, pp. 29-32, Jan. 1989.
- [8] K.K. Afridi. "A Methodology for the Design and Evaluation of Advanced Automotive Electrical Power Systems," Ph.D. thesis, Massachusetts Institute of Technology, Department of Electrical Engineering and Computer Science, Feb. 1998.
- [9] B.A. Miwa. "Interleaved Conversion Techniques for High Density Power Supplies," Ph.D. thesis, Massachusetts Institute of Technology, Department of Electrical Engineering and Computer Science, May 1992.

- [10] C. Borrego, J. Fontanilles, and J. Giro, "DC/DC conversion stage proposals for advanced 42/14 electrical and electronic distribution systems," Vehicle Electronic Systems-European Conference, Coventry, UK, pp.1.2.1-1.2.12, 9-10 June 1999.
- [11] V. Caliskan, "Design and Analysis of Dual/High Voltage Automotive Electrical Power System Architectures.," PhD thesis, Massachusetts Institute of Technology, Department of Electrical Engineering and Computer Science, 2000.
- [12] C.P.Mudannayake and M.F.Rahman, "A MATLAB/Simulink Model for a Prototype Integrated Starter Alternator for Automobiles," Power electronics and Motion Control Conference, IPEMC, The 4th International, vol. 3, pp.1679-1684, 2004.
- [13] J. C. Byrum, "Comparative Evaluation of Dual-Voltage Automotive Alternators," Technical report TR-00-012, Laboratory for Electromagnetic and Electronic Systems, MIT, Nov. 2000.

