IEEE - PEMC 2016 in Varna - BULGARIA
VARNA, BULGARIA | from 25 to 30 of September 2016
17th International Conference on Power Electronics and Motion Control

Title of Tutorial

Natural Balancing in Multilevel Converters - What You Always Wanted to Know but Had No Chance to Ask

Abstract

This Tutorial will present the original research on natural capacitor voltage balancing in multilevel converters conducted by the author over the past decade.

The first major topic is converters with capacitive filtering – reconfigurable Switched Capacitor Converters (SCC) with multiphase switching. The major contributions are related to balanced switching that makes charge flow for buck type converters as smooth as possible, newly discovered additional voltage target ratios for classic Flying Capacitor Converter (FCC) based and Fibonacci SCC topologies, and charge flow (equivalent resistance) analysis for SCC described by underdetermined linear equations (Minimal Norm principle).

The second major topic is natural balancing for different multilevel DC-DC and DC-AC converters with inductive loads or LC-filtering. Here the major results include simple and powerful time averaging based analytical methodology, understanding root causes of poor balancing, improved balancing rate by modified switching patterns, simple time domain theory for balance booster that essentially speeds-up natural balancing dynamics, understanding possible capacitor balanced voltage offsets for ideal symmetric switching and due to non-ideal unbalanced switching. Based on good natural balancing it is possible to make self-precharge that is charging capacitors to their predefined balanced voltages during power-up (start-up) at virtually no cost.

Each subtopic is illustrated by an in-depth analysis of simple representative demo cases. The presented material is self-explanatory intended for an entry / intermediate level audience.

Short Bio

Alex Ruderman obtained his MSc (with Honors) and PhD from Leningrad Electrical Engineering and Polytechnic Institutes in 1980 and 1987 respectively (both Leningrad, USSR).

In 1995-2003, Alex worked as a research scientist for Intel Microprocessor Development Center, Haifa, Israel. After teaching several electronics related courses at Bar Ilan University and Holon

Institute of Technology in 2004-2005, he joined as Chief Scientist Elmo Motion Control Ltd, Petach Tikva, Israel, the makers of compact intelligent servo drives (Elmo drives are allegedly used by NASA in Mars Curiosity mission).

Since 2013, Alex is Associate Professor at Nazarbayev University (NU), Astana, Kazakhstan, new (2010) English-speaking research oriented university. Over the past years, he has been extensively involved in research on multilevel converters (voltage / current quality evaluation and natural balancing mechanisms) and co-authored about 50 conference and journal papers on the subjects.

Alex is a regular reviewer for IEEE Transactions on Industrial Electronics and Power Electronics and a technical program committee member for several international Power Electronics Conferences. He was a member of IEEE Power Electronics Technical Committee (PETC) (2010-2013) and is currently Associate Editor for the IET Power Electronics Journal.