Contribution ID: **64** Type: **Poster**

Power Converters for Future LHC Experiments

Thursday 29 September 2011 16:00 (2h 30m)

The paper describes power switching converters suitable for possible power supply distribution networks for the upgraded detectors at the High Luminosity LHC collider. The proposed topologies have been selected by considering their tolerance to the highly hostile environment where the converters will operate as well as their limited electromagnetic noise emission. The analysis focuses on the description of the power supplies for noble liquid calorimeters, such as the Atlas LAr calorimeters, though several outcomes of this research can be applied to other detectors of the future LHC experiments. Experimental results carried on demonstrators are provided.

Summary 500 words

The electronics which will instrument experiments during the high luminosity phase at the Large Hadron Collider (LHC), will require a new sophisticated power distribution compared to the one used today. Power architecture integrating Point of Load (POL) converters deployed at the very heart of the experimental setup has been proposed to face these new requirements.
An isolated dc-dc resonant main converter (MC) supplies an intermediate "medium"voltage bus which distributes the voltage to the on-detector electronics. Point of Load converters are then implemented on Front-end Boards (FEBs) for precise voltage adaptation and regulation.
The design of these electronics equipments, which must cope with a highly hostile environment in terms of high radiation and a background magnetic field up to 2 Tesla, opens a severe tolerance issue for the integration technology.
The paper will propose suitable topologies for the MC and POL converters. It will discuss the criteria adopted in the selection of the circuits and describe their principle of operation. A set of experimental tests complete the static and dynamic characterization of the converters.
A modular approach is adopted for the MC to improve the overall reliability of the system and provide redundancy. The implemented transient-resonant topology is based upon a Switch-In-Line-Converter (SILC) and features multiple output, low switch voltage stress, soft-switching operation, first order dynamics, reduced sensitivity of power devices to ionizing radiations. It limits the overall power losses and the generated electromagnetic noise (EMI). The galvanic isolation is obtained by a dedicated planar transformer designed to reduce its overall dimension and to avoid the overheating due to the iron losses. Satisfaction of the thermal constraints of the MC was achieved by a careful thermal design of the planar transformer and the use of boards in metal cores (IMC) for mounting the most critical power components. The use of non commercial magnetic materials for the transformer core as well as the adoption of auxiliary winding to face the external magnetic field has been investigated.
The proposed solution for the POL converters makes use of high step-down ratio topologies operating at high frequency to increase the power capability of the distribution system and improve the transmission efficiency. Very high frequency configurations have been studied to develop coreless conversion stages. A special magnetic material suited to operate in high stationary magnetic field has been used to realize dedicated inductance cores.
Signal to noise measurements taken with and without POL mounted on the existing FEBs on a mock-up of the ATLAS LAr electronics will be showed for comparison to estimate system noise immunity to fixed frequency switching converters.
The adoption of special power devices with enhanced electrical parameters has been considered. The use of GaN power switches, a promising technology for high radiation environment, has been investigated. A dedicated experimental set-up focused to measure the switching characteristics of these devices will also be presented.

Author: CITTERIO, M. (INFN Milano)

Co-authors: LANZA, A. (INFN Pavia); PACCAGNELLA, A. (University of Padova and INFN Padova); SANSEV-

ERINO, A. (University of Cassino and INFN Roma); IANNUZZO, F. (University of Cassino and INFN Roma); BUSATTO, G. (University of Cassino); SPIAZZI, G. (University of Padova and INFN Padova); ALDERIGHI, M. (INAF and INFN Milano); BERNARDONI, M. (University of Parma); RIVA, M. (University of Milano and INFN Milano); DELMONTE, N. (University of Parma); COVA, P. (University of Parma and INFN Pavia); TENTI, P. (University of Padova and INFN Padova); MENOZZI, R. (University of Parma); BACCARO, S. (ENEA UTTMAT, R. C. Casaccia and INFN Roma); LATORRE, S. (INFN Milano); DE LUCA, V. (University of Cassino and INFN Roma)

Presenter: CITTERIO, M. (INFN Milano)

Session Classification: Posters

Track Classification: Power