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DC- DC Power Conversion with Voltage Ratios > 10 for LHC Upgrade Detectors DC- DC Power Conversion with Voltage Ratios > 10 for LHC Upgrade Detectors

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Our group is researching commercial power converters having voltage ratios greater than ten that are capable of running in the ATLAS Silicon Tracker high luminosity upgrade environment. The devices therefore must operate in a high magnetic field (2 T) and be radiation hard to ˜50-100 MRad and ˜ 1015 neq/cm2. These converters are to be mounted on the same multi-chip modules as the ASIC readout chips or in close vicinity without introducing any additional readout noise due to the MHz switching frequencies. Such devices will permit higher voltage power delivery to the tracker and thus increase overall power efficiency by limiting the ohmic losses in the ˜100 meters of cable between the tracker and the power sources.

Summary

There is a clear need for a new system of power delivery to the upgraded Atlas Silicon Tracker for the SLHC. Conventional powering will result in an efficiency of power delivery to the detector of about 10% with existing cables whose size are already limited in cross section due to space and mass constraints. A system featuring DC-DC converters with voltage ratios of ten will result in an estimated efficiency on the order of 80% with existing cables.

One approach to DC-DC conversion utilizes the buck regulator architecture. As DC-DC buck converters are commonly used in the commercial market, we have been surveying and testing current available devices to understand the current state of the art. Additionally we are investigating industry trends to determine if a commercial solution with our unique requirements might be forthcoming.

Foremost of our unique requirements is operation in a high magnetic field. This necessitates the use of an air core inductor, which implies the need for high switching frequencies that lie in the readout ASIC's bandwidth. Additional noise introduced by the converter is thus one of the primary concerns. The radiation hardness of the devices, and the relatively high voltage ratios needed are also of primary concern.

Over the past year we have tested a number of devices that, although they lack the high voltage ratios required, have enabled us to learn a number of lessons. For example, the one device that we irradiated with gammas up to 100 Mrad showed no change in performance. Also, we have conducted noise tests with our own custom module utilizing current Atlas ABCD ASICs connected to a large silicon strip detector and mounted with a daughter buck regulator board. We found no noise increase due to switching noise on the power and ground. Magnetic/electrical pickup on the 8 cm silicon strips from the air-core inductor required shielding to reduce the noise to a satisfactory level.

Market forces are now driving the development of a new generation of converters with ratios greater than 10. We will shortly be testing such promising devices for their radiation hardness, efficiencies and noise performance. Additionally, we have fabricated several small micro-H inductors that show promise in their initial testing. Results of the testing of the new devices will be presented.

Author: Dr DHAWAN, Satish (Yale University)

Co-authors: Mr MINCER, Allen (New York University); Mr MUSSO, Chris (New York University); Mr LYNN, David (Brookhaven National Laboratory); Mr CHEN, Hucheng (Brookhaven National Laboratory); Mr SMITH, Hunter (Yale University); Mr KIERSTEAD, James (Brookhaven National Laboratory); Mr WEBER, Marc (Rutherford Appleton Laboratory); Prof. BAKER, Oliver (Yale University); Prof. TIPTON, Paul (Yale University); Mr KHANNA, Ramesh (National Semiconductor Corp.); Mr RESCIA, Sergio (Brookhaven National Laboratory)

Presenter: Dr DHAWAN, Satish (Yale University)

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