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A DC-DC Conversion Powering Scheme for the CMS Phase-1 Pixel Upgrade

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A novel powering scheme based on the DC-DC conversion technique will be exploited to power the CMS Phase-1 pixel detector. DC-DC buck converters for the CMS pixel project have been developed, based on the AMIS5 ASIC by CERN. We will show the performance of these devices, including efficiency and line and load regulation at various temperatures. Reliability studies based on a preseries of 200 DC-DC converters as well as mass production techniques for the inductor and the magnetic shielding will be presented. Results from system tests of the full power chain of the pixel barrel detector will be discussed.

Summary

The CMS pixel detector will be replaced during the 2016/2017 shutdown with a device that features a higher hit efficiency, a smaller material budget and an improved radiation-tolerance. The new pixel detector will have one more layer of pixel modules with respect to the present detector, both in the barrel part and the end caps. A novel powering scheme based on the DC-DC conversion technique will be exploited to power the new detector, which comprises 1.9 times the channels of the present device.

We have developed DC-DC buck converters for the CMS pixel project, based on the AMIS5 ASIC by CERN. We will show the performance of these devices, including efficiency and line and load regulation at various temperatures, and a comparison of switching noise for various board layouts. A preseries of 200 DC-DC converters will allow us to study the quality and reliability with large statistics, for example with thermal cycling. Mass production of the toroid inductor and the magnetic shielding of the inductor was established and will be presented.

A prototype of the full power chain of the pixel barrel detector, comprising of 26 DC-DC converters, a DC-DC converter motherboard, the final power supplies (adapted to the DC-DC conversion scheme), further PCBs and cables, high voltage boards, a two-phase CO₂ cooling system, and the CMS pixel modules themselves, has been set up. Electrical and thermal results from these system tests will be discussed.

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