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A DC-DC conversion powering scheme for the CMS pixel detector upgrade

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CMS has adapted a DC-DC conversion powering scheme for its phase-1 pixel upgrade, to be able to deliver the required amount of power with the existing cable plant.

The presentation will focus on aspects that are relevant for the integration of DC-DC buck converters into a detector system. New measurements based on a full-scale prototype ASIC (AMIS4, CERN PH-ESE) will be presented, including the cooling performance with a CO2 system, reliability at low temperature, studies of potential frequency locking between DC-DC converters, and system tests with many DC-DC converters and several pixel modules.

Summary

The CMS Tracker Collaboration forsees an upgrade of its pixel detector in the shutdown 2016/2017. Improvements include one additional layer and disk, respectively, less material, a CO2 cooling system, and reduced deadtime at large hit rates, due to a new readout chip. The new detector will comprise a factor of 1.9 more channels, and consequently the power consumption will increase by almost a factor of two. Since this power has to be supplied with the installed cable plant, a novel powering scheme is mandatory. A powering scheme based on the DC-DC conversion technique has been chosen.

We develop DC-DC buck converters, based on the AMISx chip family by CERN, specifically for the application in the CMS pixel detector. The current DC-DC converters, based on the AMIS4 full size prototype ASIC, will be introduced and their performance will be presented. Their integration into the CMS pixel detector will be described. The focus of our studies is on system aspects. System tests with up to eight AMIS4 converters and two CMS pixel modules have been performed, and show no degradation of the module noise performance. DC-DC converters feature an efficiency of the order of 80% and thus dissipate considerable heat. Cooling of the DC-DC converters is therefore mandatory and has been studied both with standalone measurements and with a prototype CO2 cooling system. A dedicated service board for 24 DC-DC converters has been developed and first performance tests with a fully equipped board will be presented. Further studies include thermal cycling of converters down to the future operating temperature, and an investigation of potential frequency locking of several DC-DC converters.

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