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Performance and Plans for Production of the Powerboard for ATLAS ITk Strip Barrel Modules

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The Inner Tracker silicon strip detector (ITk Strips) is a part of the ATLAS upgrade for the HL-LHC. It employs a parallel powering scheme for the high voltage sensor bias and the low voltage to power readout ASIC's. This design requires on-module DCDC conversion and high voltage switching. These are implemented on the Powerboard using a buck converter (bPOL12V) to drop the low voltage, a GaNFET for the HV switch, and a custom ASIC (AMAC) for control and monitoring. This contribution will present the Powerboard performance and the test system that will be used for the production of 15,0000 Powerboards.

Summary (500 words)

The ATLAS upgrade for the HL-LHC contains a new silicon tracker called the Inner Tracker (ITk). The ITk Strip detector is a subset of the ITk with striped silicon sensors. It will employ a powering scheme where a single power supply provides power to several modules in parallel. This includes both the high voltage to bias the sensor and the low voltage to power the on-module electronics. The low voltage is supplied to the supporting stave structure using an external 10-11V. The power of a single module will be managed using a custom electronics board called the Powerboard. The Powerboard has four main functionalities; employ a rad-hard switching DCDC regulator (bPOL12V) to step the low voltage from 11V down to 1.5V for local power, monitor the low and high voltage currents directly on a module, disable power in case of module failure and monitor the local temperature. The last three tasks are accomplished using a custom ASIC called the Autonomous Monitor And Control (AMAC) chip. The AMAC is powered using a rad-hard linear regulator (linPOL12V).

The prototyping phase of the project has been completed. The Powerboard has been successfully used at all levels of the prototype ITk Strips system, ranging from standalone tests to operations on a stave consisting of 14 modules per side. Dedicated tests to ensure radiation hardness and reliability after continuous thermal cycling were performed.

The pre-production of the Powerboard has now started. This phase focuses on scaling the manufacturing procedures to handle the final production of 15,000 Powerboards required for the barrel of the ITk Strip upgrade. A commercial partner that can handle SMD loading and wire bonding has been identified and assembled the first batch of 250 Powerboards. This first batch has gone through a stringent quality assurance (QA) and control (QC) process to ensure high reliability. The QA involves a comprehensive stress testing of a random sampling from each batch. The QC tests are done on every board to identify problems during the assembly. The QC involves standard manufacturing controls followed by a full electrical tests and burn-in.

An all-in-one custom test system was developed to aid with the electrical tests. It consists of a passive carrier board containing multiple Powerboards connected to an active board for testing. The active board contains all necessary circuits to test AMAC communication, monitor low and high voltage power outputs, measure the bPOL12V efficiency at varying loads and detect any EMI outside of the shield box. It is controlled by a commercial mezzanine card containing a Xilinx Zynq-7000 SoC FPGA. The operator connects to the system via a web server running on the SoC. The test setup can be operated in a custom crate for mass burn-in or on table-top for initial electrical testing and reception tests at module assembly sites.

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