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Production and Testing of the Powerboard for ATLAS ITk Strip Barrel Modules

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The upgrade of the ATLAS ITk strips detector for HL-LHC will employ a custom PCB (Powerboard) for on-module DC-DC conversion, HV switching, and monitoring. This contribution will present the production procedure and mass test system for 15,000 Powerboards. We will also present the challenges identified during prototyping and pre-production and the performance of the Powerboard with the latest DCDC converter (bPOL12V) and controlling ASIC (AMACStar). Reliability tests of various components on Powerboards were also performed and results will be presented.

Summary (500 words)

As part of the ATLAS upgrade for HL-LHC, the inner silicon tracker called the Inner Tracker (ITk) will employ parallel powering scheme to power several modules from a single power supply for both the bias of sensors (HV) and the power of readout electronics (LV). This powering scheme is achieved by a custom PCB called Powerboard. The Powerboard uses a buck converter (bPOL12V) to convert the 10-11V line from the stave to 1.5V for the on-module readout electronics power. The Powerboard is also responsible for switching the HV via a commercial GaNFET. The control of LV and LV and monitoring of the power (voltage and current) and temperatures are achieved with a custom ASIC (AMAC).

The performance of the Powerboard has been validated on modules during proto-typing and pre-production phase of the ITk strips upgrade. Few technical challenges were identified during the testing of the components, including TID effects and SEE for AMAC, and bPOL12V noises. Revision of those ASICs has been finished. The test result of the powerboard with the new ASICs (bPOL2V v6 and AMACStar) will be presented.

One of the main challenges ahead is the production of around 15,000 Powerboards over the course of two years. The PCB manufacturing, SMD loading, and wire bonding will be done by commercial partners. The testing of the Powerboard involves visual inspection, electrical tests, thermal and irradiation tests, among which the extensive electrical tests and thermal cycling of each individual Powerboard are the most time consuming steps. Electrical tests include basic functionality tests such as AMAC communication tests, ON and OFF measurements of the LV and HV, temperature monitoring tests; it also includes characteristic measurements of individual components on the Powerboard, such as LV input voltage scan, efficiency measurement of the DCDC converter at different loads, HV current scan, calibration and full range scan of each DAC and ADC channels on AMAC, etc. To efficiently perform electrical tests and thermal cycling, a mass test crate has been designed and commissioned. The mass test crate is able to test a few hundreds of Powerboards at a time with fully automized testing procedure, aiming to be able to perform the tests with minimum human interaction. The mass test crate houses several passive carrier boards, with each carrier board containing multiple Powerboards connected to an active board for testing. The active board contains all necessary circuits to for electrical tests which are controlled and programmed by a commercial mezzanine card containing a Xilinx Zynq-7010 SoC FPGA. The operator connects to the system via a web server running on the SoC.

In addition to the whole board test of each Powerboards, reliability stress tests of several key components on the Powerboard have also been performed. This includes thermal shock and irradiation tests of the flex PCB material via a test coupon, and long-term high current stress tests of the linear regulator (LinPOL12V) which is responsible for powering the AMAC chip. Results of such reliability tests will also be presented.

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