Strip sensor performance in prototype modules built for ATLAS ITk


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Abstract

More than 80 ATLAS ITk prototype strip modules were built with ATLAS12 sensors [1-2]. They were tested with electrical readout on the per-channel basis. In general, an excellent performance was observed, consistent with previous ASIC-level and sensor-level tests. However, the lessons learned included two phenomena important for the future phases of the project. First was the need to store and test the modules in a dry environment due to humidity sensitivity of the sensors. The second was an observation of high noise region for some modules. About 2.5% of modules were affected.

The high noise regions were tested further in several ways, including monitoring the performance as a function of time and bias voltage. Additionally, direct sensor-level tests were performed on the affected channels. The inter-strip resistance and bias resistance tests showed low values, indicating a temporary loss of the inter-strip isolation. A subsequent recovery of the noise performance was observed. We present the test details, an analysis of how the inter-strip isolation affects the module noise, and relationship with sensor-level quality control tests.

INTRODUCTION

Modules (Figure 1) typically exhibit good electrical performance [3]. The ambient humidity for both module testing and storage affected the breakdown voltage (Figure 2). When kept dry, the sensors had good performance throughout the assembly steps (Figure 3). Further humidity sensitivity studies are shown in submission by Javier Fernandez-Tajera et al., “Humidity Sensitivity of Large Area Silicon Sensors: Study and Mitigation” (Tuesday afternoon).

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There were 2 occasions, out of over 80 modules built, when there was a region of high noise exhibited. This region comprised about 35 strips out of 5120 total on this module type. This region seemed to pertain to the sensor performance:

- There was no correlation with the hybrid-level noise performance, or readout from a different strip row by alternating channels on the same ASIC (Figure 4).
- The noise level strongly depended on the bias voltage (Figure 5).
- The noise level changed over ~1 month time scale.

Figure 1 A module with ATLAS12 sensor module.

Figure 2 Breakdown evolution at different assembly steps and humidity levels.

Figure 3 IV test for 17 modules kept in dry environment.

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References

3) L. Poley et al., “The ABC130 barrel module prototyping programme for the ATLAS strip tracker,” to be submitted to J. Instrumentation.