Serial powering of ATLAS silicon strip sensors

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Serial powering of silicon modules is a novel powering scheme that promises to reduce the volume of power cables, the passive detector material, the total power, and the costs of future silicon trackers by large factors. These benefits of serial powering are crucial for silicon strip detectors for Super-LHC, which will have ~60 million electronic channels and a silicon sensor area of ~200 m^2. The success of serial powering hinges on the noise performance and protection against failure modes, which could possibly lead to the loss of a whole chain of modules.

We present experimental results obtained with six ATLAS Semiconductor tracker (SCT) modules powered in series. The noise performance of serially powered modules is shown to be as good as or better than that of modules powered independently. The sensitivity of modules powered in series to different noise sources has been studied quantitatively by several means, including the injection of a noise current (as a function of frequency) and results are presented.

Two different schematics for the AC-coupling of clock, data and command signals are used in this serial powering implementation and will be discussed. The circuitry performance was found to function well for clock frequencies of 1 Hz to well above 50 MHz at a wide range of duty cycles. DC-balanced protocols are not required.

The measured power efficiency is compared with analytical estimates as a function of cable resistance. The power budget of the serial powering circuitry is dominated by the excess current lost in the shunt regulator power transistor and thus depends on the module electronics rather than the specific implementation of the shunt circuitry.
Failure modes and the protection against these are discussed.