Contribution ID: **75** Type: **Oral**

Serial Powering of Silicon Sensors

Thursday, 6 September 2007 12:40 (25 minutes)

Serial powering of silicon sensors will reduce the volume of power cables, the passive material and power losses in cables of future silicon trackers by large factors. These benefits are crucial for silicon tracking at the Super-LHC. Noise performance and grounding and shielding of densely packaged modules are key challenges for serial powering. We extended our studies with six ATLAS Semiconductor Tracker (SCT) modules to enable noise measurements in different geometrical configurations and for various sources of injected noise. We will present measurements obtained with a silicon strip supermodule. We will discuss the specifications of radiation-hard custom serial powering circuitry.

Summary

Current silicon detector systems for particle physics and elsewhere power individual detector modules independently. For large scale detectors, like the ATLAS Pixel detector and the ATLAS Semiconductor Tracker (SCT), this implies that tens of thousands of cables are needed to power the front-end electronics. The power cables are well above 100 m long (one way) and their resistance (including return) can be as high as 4.5 ohms. The power consumed by the front-end electronics is typically tens of kW; power efficiency is as low as 30% -50% due to thermal losses in cables. For future detectors, with five or ten times more electronic channels, independent powering is not practical. Serial powering provides an elegant solution to these problems and is of great interest for SLHC and ILC trackers and elsewhere.
A serial powering system for silicon detectors consists of four basic elements: a current source; a shunt regulator and power transistor (for digital power); a linear regulator (for analog power); and AC or opto-coupling of clock, command and data signals. The modules are all chained in series. The number of long cables can thus be reduced by a large factor, depending on the number of modules powered in series. The power efficiency is increased hugely.

We have extended our previous results [1] on noise performance substantially to include the effects of the following noise sources: injection of a voltage pulse in the serial powering line and a fluctuation in the current - source current. We also built a dedicated set-up to position two SCT sensors at a close distance of a few mm and measured their noise performance. We built and tested a silicon supermodule with six sensors powered in series.

Failure protection modes have been identified and compared quantitatively with independent powering schemes. In one failure condition where the module would become disconnected from the regulator circuitry, the shunt regulator power device would have to withstand the full module current. We designed and tested circuitry to sense an over-current condition and to reduce the regulator output voltage to a minimum value to minimize thermal stress due to extra power dissipation.

Measurements taken in the various configurations will be presented and discussed. The focus will be on noise performance, which so far is excellent.

Currently custom radiation-hard serial powering circuitry is not yet available for implementation in silicon strip detector systems. We will present different alternative shunt regulator architectures. We will discuss the specifications of a general-purpose radiation-hard serial powering ASIC for tracking detectors at SLHC and elsewhere.

Serial powering is compatible with data communication of power lines. Time permitting, we will introduce a novel scheme for full-duplex bi-directional data communication in serial powering systems, which could be of interest for slow-control applications.

[1] Marc Weber, Giulio Villani, Robert Apsimon, "Serial Powering of Silicon Strip Detectors at SLHC", Proceedings of the 6th "Hiroshima"conference on Silicon detectors (2006), accepted by NIM A.

Primary author: Dr VILLANI, Giulio (Rutherford Appleton Laboratory)

Co-author: Mr PARTANEN, Niko (Rutherford Appleton Laboratory)

Presenter: Dr VILLANI, Giulio (Rutherford Appleton Laboratory)

Session Classification: Topical 2: Detector Power Supply and Distribution 2