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Serial Powering of Silicon Strip Modules for the ATLAS Tracker Upgrade

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The costs, difficulties and inefficiencies associated with the cabling of silicon detector systems are well known. Serial Powering is an elegant solution to these issues and is being actively pursued by the ATLAS Tracker upgrade community.

Demonstrator supermodules have been produced using the ABCD chip from the present ATLAS SCT together with serial powering circuitry built from commercial components. Two 6 module supermodules have been built, and construction of a third supermodule to a 30 module desgin is in progress. Recent results from these supermodules will be presented.

Elements of the serial powering scheme have been incorporated into new ASIC designs, and studies of system issues such as protection schemes have advanced greatly. Time permitting, these developments and their application to the next demonstrator supermodule will also be outlined.

Summary

In the current generation of silicon detector systems for particle physics experiments, it has generally been considered best practice to power each detector module independently. For example, the present ATLAS SCT detector uses 4088 independent power supply channels and cable chains, one for each detector module. Physically routing the cables into the detector volume can be a major challenge in itself, and with return path cable resistances of order 4.5 ohms power efficiency is generally poor due to thermal losses in the cables.

Independent powering is not a practical solution for future detectors, where the total channel count may be expected to increase by a further order of magnitude. The ATLAS Tracker upgrade community are actively pursuing the serial powering alternative.

With serial powering, a number of detector modules are connected together in series to a constant current source. Each module has its own shunt regulator and power transistor combination to provide digital power and a linear regulator is used to provide analogue power. Each module will now be at a different potential with regard to the off detector readout electronics, so it is also necessary to provide AC or opto coupling for all clock, command and data signals.

Demonstrator “supermodules” have been produced to two designs using the ABCD chip from the present ATLAS SCT together with serial powering circuitry built from commercial components. The first design uses six modules, each with 4 chips coupled to 6cm strip sensors, together with an implementation of serial powering circuity in the form of a small PCB. In the more recent design, which comprises (up to) thirty modules with 3cm strip sensors, the serial powering circuity has been integrated into the 6 chip hybrid. Recent results from these demonstrator supermodules will be presented.

Looking ahead, elements of the serial powering scheme have been incorporated into the ABCn readout ASIC and the SPi serial powering chip. Protection schemes have been developed such that, in the event that a single module should fail, the remainder of the modules in the chain may continue to operate, and the design of a custom, constant current power supply has been started. Time permitting, these developments and their application to the next demonstrator supermodule will also be outlined.

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