APC (CNRS/UPC UMR7164)
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Subject : *High Sensitivity On-Chip BiCMOS Thermometer with Differential readout and Offset Nulling*

Six months M2 internship at APC, March-September 2022

In spacecraft, all subsystems are monitored in temperature. For integrated circuits, this is crucial to compensate for thermal drifts. The thermal dependencies of the "bandgap voltage" of p-n junctions are commonly used for ASIC thermometry. A precise and sensitive, on-chip, thermometer, with no common-mode coupling based on BiCMOS circuits will be studied. The proposed subject is focused on sensitivity optimization of a silicon based thermometer. The particularities of its design are offset compensation around room temperature, and the propagation of a differential signal allowing it to be readout without common-mode coupling. Integration of such an on-chip thermometer into low-noise satellite front-end readout ASIC also requires power consumption optimization and the ability to operate in the space environment.

ASICs precise thermometry can increase the robustness and reliability of the space instruments in which the APC laboratory contributes. These challenges therefore constitute a rich and ambitious instrumental internship subject. It fits perfectly into the perspectives of our current instrument developments, in particular within the framework of the readout chain of the X-IFU instrument for the ATHENA space mission. Beyond these applications, the on-chip thermometry developed at APC is an innovative subject that meets current needs in the general field of microelectronics.

The student is required to have strong skills in electronics, microelectronics and controlled systems. He/she will first need to understand the state of the art of "on-chip" thermometry techniques, specially studying the AD590 thermometer as an existing example. An analytical study will be required to establish the trade-offs between technology, supply voltage, power consumption and sensitivity. For simulations and circuit design, Cadence Virtuoso CAD tools are preferred. The student will also participate into the characterizations of two existing BiCMOS thermometers based on two ASIC technologies (AMS350 and ST130) in a temperature range from $-20°C$ to $+80°C$. A comprehensive analysis and comparison of these measurements will be reported. The internship will be performed with the support of an existing team of microelectronic engineers and instrumentalists.

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