

Development of the Readout Electronics Architecture for the ASTRA-LEO Payload

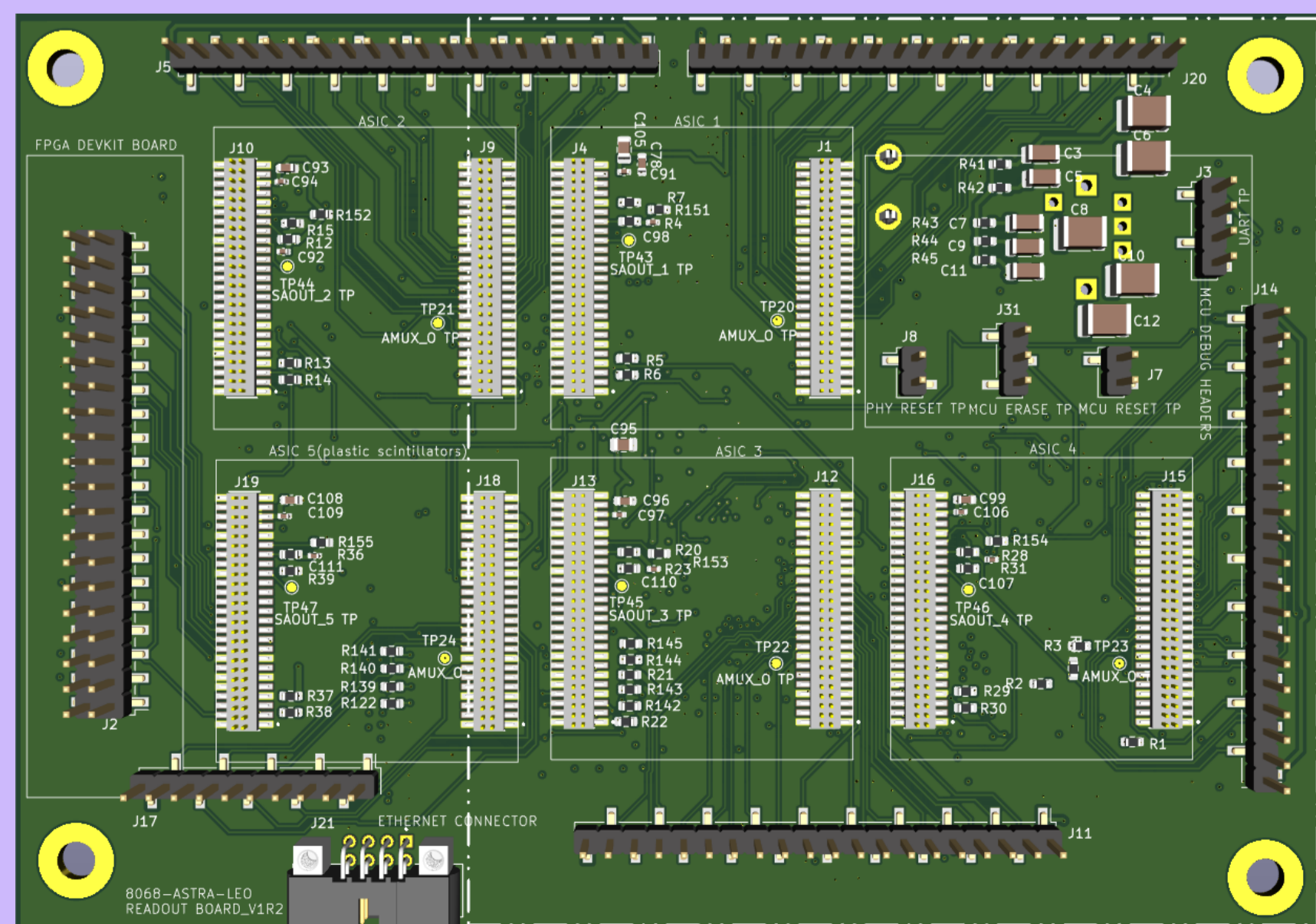
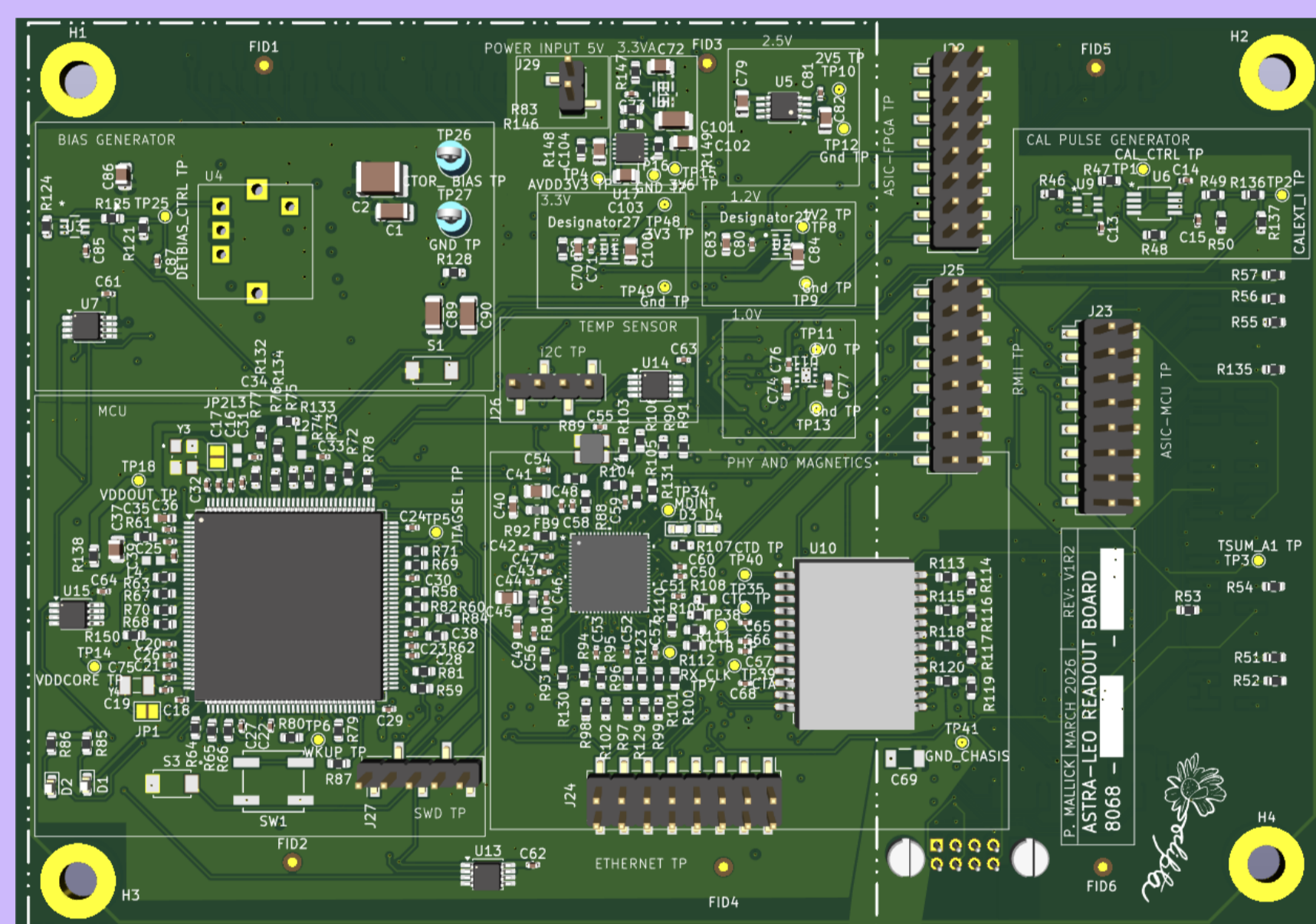
Purpose and Aim

This project focuses on the design and development of a robust readout electronics architecture for the ASTRA-LEO payload, intended for radiation detection in Low Earth Orbit (LEO). The primary motivation is to enable accurate detection and characterization of high-energy particles in space, which is essential for space weather monitoring, radiation mapping, and the protection of onboard electronics.

The readout electronics is designed to interface directly with silicon photomultipliers (SiPMs) coupled to scintillator detectors, converting fast analog pulses into digital data suitable for further processing. The system includes analog front-end circuitry for signal amplification and shaping, followed by digitization and processing using dedicated ASICs, an FPGA, and a microcontroller. Key design goals include achieving low-noise performance, high signal integrity, precise timing, and efficient data acquisition, while meeting strict constraints on power consumption, size, and reliability for space applications.

System Design and Implementation

- Designed a complete readout electronics architecture integrating detector interfaces, analog front-end, digitization, and data processing units
- Developed signal conditioning circuitry for silicon photomultipliers outputs, enabling reliable acquisition of fast scintillation pulses with optimized gain and noise performance
- Designed low-noise power supply subsystems using DC-DC converters and LDO regulators to ensure stable operation across all components
- Implemented a multi-layer PCB with careful mixed-signal layout, including grounding strategy, impedance control, and electromagnetic compatibility considerations
- Integrated key components including ASICs, FPGA, and microcontroller for efficient data acquisition and processing
- Developed a scalable and modular architecture suitable for multi-channel detector systems and future space-based radiation detection applications



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