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MODULAR CIRCUIT BOARD DESIGN FOR SMALL SATELLITES: OPTIMIZING POWER, THERMAL, AND EMI PERFORMANCE

Abstract

As small satellites evolve to support increasingly complex missions, their electronic subsystems must be designed for versatility, efficiency, and reliability in the harsh environment of space. Planet's approach to spacecraft electronics leverages modular circuit board design, enabling flexible integration of various subsystems while maintaining robust performance across diverse thermal and power conditions. This strategy enhances manufacturability, streamlines qualification, and ensures adaptability across multiple satellite configurations.

This paper explores the key engineering considerations involved in developing modular circuit boards for small satellites. These include thermal management strategies to dissipate heat efficiently in vacuum, power distribution optimizations to support payloads and critical avionics, and EMI mitigation techniques to ensure electromagnetic compatibility among tightly integrated systems. The Qualification

team collaborates with system engineers and avionics designers to validate these designs through rigorous environmental testing, ensuring they can withstand temperature cycling, vacuum conditions, and launch-induced mechanical stresses.

A particular focus is placed on design standardization and scalability, allowing circuit boards to be repurposed across multiple spacecraft generations while accommodating mission-specific customizations. Additionally, the paper highlights advancements in automation and testing methodologies, enabling more efficient verification of circuit board performance before spacecraft integration.

By adopting a modular, system-aware approach to circuit board design, Planet enhances the reliability, manufacturability, and adaptability of its small satellite platform, accelerating mission deployment while maintaining stringent qualification standards. This work underscores the importance of cross-disciplinary collaboration and forward-thinking engineering in advancing the capabilities of small satellite electronics.