Paper ID: 97764
student

IAF SPACE SYSTEMS SYMPOSIUM (D1)
D1 - Extra session (8)

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# AI-DRIVEN APPROACHES TO ADAPTIVE DERATING FOR SPACE SYSTEMS

**Abstract**

Derating is a fundamental practice in spacecraft electronics, ensuring components operate below maximum stress ratings to improve longevity and resilience in extreme conditions. Current derating methodologies, such as those outlined in NASA EEE-INST-002 and MIL-HDBK-217, rely on predefined safety margins and manual verification through Worst Case Circuit Analysis (WCCA). While effective, these approaches are often time-intensive, inflexible, and contribute to mass overdesign, a growing challenge as missions demand lighter, more cost-efficient spacecraft.

With advancements in artificial intelligence and machine learning, there is an opportunity to explore data-driven derating optimization tailored to mission-specific environments. This paper investigates how historical failure data and predictive models could enable a more dynamic derating strategy, adjusting safety margins based on component specifications, environmental stressors, and operational conditions. We propose a framework where machine learning models trained on historical mission data could assist engineers in derating decision-making, reducing design cycle time, and improving mass efficiency.

To assess feasibility, we discuss a potential AI-assisted derating workflow, including data extraction from failure databases, supervised learning approaches, and circuit-level validation methods. We explore how AI-driven derating recommendations could be tested against traditional standards through simulation-based analysis, ensuring that reliability is maintained while optimizing design constraints.

This paper presents AI-driven derating as an enabling technology that enhances spacecraft design efficiency by dynamically optimizing safety margins, reducing overdesign, and automating Worst Case Circuit Analysis (WCCA). By addressing key challenges and outlining a roadmap for integration, we highlight how machine learning can transform derating from a static rule-based process into an adaptive, mission-specific reliability tool for future space systems.