

Effective Small-Satellite Radiation Assurance for Non-Specialists Rebekah A. Austin, B. D. Sierawski, A. F. Witulski, R. D. Schrimpf, R. A. Reed, G. Karsai, N. Mahadevan Contact: Rebekah.a.Austin@vanderbilt.edu This work supported by NEPP and NASA OSMA Grant and Cooperative Agreement Number 80NSSC18K0493 Why use a model-based approach for RHA? the radiation-induced What is radiation hardness assurance gh the systems? Captures a "digital copy" - Enables knowledge capture, sharing, and continuity Radiation effects and reliability ultimately need to ferent part types analyzed at the system level opagate through the Knowledge about the system is needed Complements and uses model-based system engineering processes and languages onalities: How do designers capture and analyze radiation e (SysML) hardness assurance activities? Use graphical arguments like Goal Structuring Notation to link arguments with models of the system sML block diagrams) ture (GSN) <<Requirement>> Radiation Goal **Ref - SEB Requirement** ld : RAD1 Part survives SEB Hardness adiation-related tools Text: Assurance – CRÈME The probability of failure from SEB shall be – R-GENTIC less than 1% Strategy **Determine part** susceptibility to SEB Reliability assurance.org Strategy Ariver for A Auxiliary Flyback Channel Power • Estimate Requirement environment Controller Vsense, CSA &CSE • Perform radiation Goal Probability of failure from U1-Ref ulate probabilit SEB is less than 1% Ref SysML Block <<Requirement>> << Block >> Strategy Power Diagram SRAM. ld : RAD3 • Estimate SRAM. SRAM. Radiation environment ELS_FI... SRAM... • Perform radiation WDI uC_LT Text: Environment test Calculate failure probability or greater << Block >> DUT::SRAM << Block >> Logic_Translation VCCB VCCA Ref - Goal Contr. Contr → Control Goal Goal Addre. Address Addre. Perform radiation test Estimate environment Dataln failure Contemporation Detailed DataO.. <<Requirement>> Ref - SEB Test Requirement ld : RAD2 Solution Solution Text: Results of test Environment description F Heavy ion testing Calculate probability o shall be performed to ar failure Witulski et al. Mizuta et al. Lauenstein et al. ב¹²⁰⁰ ד 1000 ב LET of 37 MeV-cm²/mg SEL urrent CREME-Ref C - 600 <u>عَ</u> **1** Solution Probability of failure 10 20 30 40 50 10¹¹ Worst Day SPE LET [MeV-cm²/mg] Radiation Cumulative SPE: — C = 99% irrent Bus_A -→ 1100 V -→ 850 V -→ 650 V -→ 600 V TID **Test Results Reliability** Out_of_spec_Logic **Prediction** 10⁻¹ 10⁰ LET (MeV-cm²/mg) Bus_B

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