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Circuit Protection Using High-Speed Circumvention

Oak Ridge National Laboratory is developing the Chemical Biological Mass Spectrometer, Block II (CBMS II) for the U.S. Army Soldier and Biological Chemical Command. The instrument is a candidate for deployment on tactical vehicle platforms including the M93A1 Fox and the Lightweight Nuclear Biological Chemical Reconnaissance System vehicles. The instrument provides substantial improvements over other fielded systems in sensitivity, selectivity, and accurate identification for a wide range of chemical and biological agents.

Built around an ion-trap mass spectrometer, the instrument contains sixteen custom-designed and five commercial off-the-shelf (COTS) circuit assemblies including two COTS single-board Pentium computers and a COTS graphics display. Twenty-nine DC-DC converters are employed in the instrument's distributed power system.

Environmental requirements for the system include radiation-tolerance specifications for neutron dose, gamma dose rate, and gamma total dose. This report focuses on advances made in circumvention technology used to protect sensitive circuitry from high gamma dose rates. These new designs clamp power rails to ground much more quickly after detection of a nuclear event than had previously been recommended for circumvention circuits. As a result, especially vulnerable components, including high-density CMOS field-programmable gate arrays (FPGAs), application-specific integrated circuits (ASICs) and microprocessors, are adequately protected.

A wide variety of CBMS II custom and retrofitted COTS circuit assemblies were tested by the Army's Directorate for Applied Technology Testing and Simulation at the relativistic electron beam accelerator (REBA) facility at White Sands Missile Range and at the HERMES III facility at Sandia National Laboratory. No failures were induced even when the equipment was subjected to gamma dose rates several times higher than system specifications require.

Design details including adaptations for isolated power supplies and for highly integrated COTS computer boards are discussed. This protection technique is applicable to a wide variety of sensitive electronic circuits.

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