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SPACE RADIATION HARDNESS ASSURANCE OF A SATELLITE WITH THE USE OF PROTECTIVE MATERIALS

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Abstract

High cost and low availability of the components certified for use in the space environment forces satellite designers to using industrial and even commercial items. Risks associated with insufficient knowledge about behavior of these components in radiation environment are parried, mainly, by careful radiating designing of a satellite where application of special protective materials with improved space radiation shielding characteristics is one of the most widely used practices. Another advantage of protective materials application appears when a satellite designer needs using equipment in more severe space environment conditions then it has been provided at the equipment development. In such cases only expensive repeated qualification of the equipment hardness can be alternative to protective materials application. But mostly this way is unacceptable for satellite developers, being within strong financial and temporal restrictions. To apply protective materials effectively, the developer should have possibility to answer the question: "Where inside a satellite shall I place these materials and what shall be their shape to meet the requirements on space radiation hardness with minimal mass and volume expenses?" At that, the minimum set of requirements on space radiation hardness include: ionizing dose, nonionizing dose, single events, and internal charging. The standard calculative models and experimental techniques, now in use for space radiation hardness assurance of a satellite are unsuitable for the problem solving in such formulation. The sector analysis methodology, widely used in satellite radiating designing, is applicable only for aluminium shielding and doesn't allow taking into account advantages of protective materials. The programs simulating transport of space radiations through a substance with the use of Monte-Carlo technique, such as GEANT4, FLUKA, HZETRN and others, are fully applicable in view of their capabilities; but time required for calculations with use of these tools makes their utilization extremely problematic in the engineering practice. The calculative and experimental technique developed by the authors allows estimation of ionizing dose, nonionizing dose, single events, and internal charging of solar and trapped electron and proton radiations at the requested points inside a satellite when the special protective materials have been applied. The results of developed technique application are in satisfactory agreement with the results achieved with the help of the standard calculative models.