Additive Effects in VLSI Circuits for Space Application under the Influence of Voltage Pulse Train and the Arrhenius Law

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Abstract. In the space industry, the increase in the active service life of spacecraft (SC) is considered a current problem. One of the causes that leads to damage and decrease in the service life of SC is the effect of internal electrification. Voltage pulses caused by the effect of internal electrification affect the components of the radio electronic equipment of SC and can result in damage of electronic components. The influence of a pulse train with an energy lower than the threshold of failure leads to the effect of damage accumulation inside the components (additive effect). As a result, a failure occurs during the influence of the pulse with an energy lower than that of the threshold. The paper analyses the existing experimental results on revealing the additive effect. The effect of the influence of a voltage pulse train of subthreshold energies that affect very-large-scale integration circuits (VLSIC) created using modern submicron technologies are given. The obtained experimental results prove the presence of the additive effect in VLSIC under the influence of the voltage pulse train of subthreshold energies and make it possible to derive a dependence describing the character of the accumulation effect of damage in VLSIC. The derived dependence correlates well with the Arrhenius equation. It is the evidence that the failure in VLCIC under the influence of a voltage pulse of subthreshold energies is thermal in nature. Based on this dependence, a method to test the resistance of electronic component base (ECB) to the influence of the voltage pulse train is suggested.

Keywords: additive effects, internal additive effects, internal electrification, single voltage pulses