The Radiation Effect on Low Noise Amplifier Implemented in the Space-Aerial-Terrestrial Integrated 5G Networks

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Abstract

This paper provides the details of a study on the effects of electron irradiation on two Low Noise Amplifiers (LNA), the Gallium-Arsenide (GaAs) pseudomorphic high electron mobility transistor (pHEMT) based and the Silicon-Germanium (SiGe) Heterojunction Bipolar Transistor (HBT)-based. Previous studies have shown that the properties of GaAs and SiGe HBT's are very tolerant of gamma, neutron, and proton irradiation without additional radiation hardening. Nowadays, commercials on the shelves (COTS) LNAs have been used in CubeSat space communication systems which may be connected to other communication networks for the implementation of the space-aerial- terrestrial integrated 5G network (SATIN) systems projects, for satellites, launched into Low and Medium Earth Orbits. Previous studies suggest that the electron radiation in space may degrade the LNAs' performance and might even lead to its failure. Located at the front end of the communication receiver system, this paper conducted such investigation to evaluate the performance under the radiation of the GaAs and SiGe LNAs considering the physics of the technology of each LNA, respectively. The results indicate that both SiGe and GaAs technologies are affected after electron irradiation. As a result, this degradation of the LNAs' performance affected the communications system performance of the inter-satellite radio link. After the assessment of the quality performance of the communication link at the system level, it has been found that the inter-satellite space link will be at risk under high space radiation dose and the link BER degrades proportionally to the radiation dose level.

Keywords

Author Keywords: 5G mobile communication; Satellite broadcasting; Gallium arsenide; Silicon germanium; CubeSat; Signal to noise ratio; Low earth orbit satellites; Degradation; electron irradiation; gallium arsenide; inter-satellite link; low noise amplifier; silicon germanium; 5G

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