

The radiation hardened linear positive voltage regulator

S. B. Rybalka, E. A. Kulchenkov and A. A. Demidov

Bryansk State Technical University
7 50 let Oktyabrya blvd., Bryansk, 241035, Russia

Received 18.06.2024; revised 14.08.2024; accepted 12.09.2024

The effect of the total ionizing dose of ionizing radiation on the operation of linear positive voltage regulator IS-LS3-5V with a low dropout voltage using the developed research complex hardware-software complex was studied experimentally and theoretically. It is established that by parameters of output voltage and minimum dropout voltage the voltage regulator IS-LS3-5V demonstrates radiation resistance to the effects of the total ionizing dose and maintains a functional state without failure in the tested ionizing radiation interval. The analytical dependence of output voltage and minimal dropout voltage on total ionizing dose of ionizing radiation is determined. A schematic diagram and a SPICE macromodel of a IS-LS3-5V voltage regulator have been developed for electrical modeling of the output voltage, taking into account the value of the total ionizing dose during radiation exposure.

Key words: integrated circuit; voltage regulator; electrical characteristics; ionizing radiation; total ionizing dose effects; SPICE.

REFERENCES

1. Volovich G. I., Circuit Technique of Analog and Analog-digital Electronic Devices, Moscow, DMK Press, 2018 [in Russian].
2. Patrick D. R., Fardo S. W., Richardson R. E. and Chandra V., Electronic Devices and Circuit Fundamentals, Gistrup, River Publishers, 2023.
3. Geytenko E. N., Secondary power supplies. Circuitry and Calculation, Moscow, Solon Press, 2008 [in Russian].
4. Korshunov F. P., Bogatyrev Yu. V. and Vavilov V. A., Effects of Radiation on Integrated Circuits, Minsk, Nauka i Tekhnika, 1986 [in Russian].
5. Zebrev G. I., Radiation Effects in Highly Integrated Silicon Integrated Circuits, Moscow, NIYAU MIFI, 2010 [in Russian].
6. Tapero K. I. and Didenko S. I., Fundamentals of Radiation Resistance of Electronic Products: Radiation Effects in Electronic Products, Moscow, Izd. dom MISiS, 2013 [in Russian].
7. JSC "KREMNY EL". New developments [electronic resource] URL: <https://group-kremny.ru/katalog-izdeliy-elektronnoy-tekhniki/Новые%20разработки%202023.pdf>
8. Rybalka S. B., Demidov A. A. and Kulchenkov E. A., Usp. Prikl. Fiz. (Advances in Applied Physics) **11** (5), 446 (2023) [in Russian].
9. LM2937 500-mA Low Dropout Regulator, Texas Instruments [electronic resource] URL: <https://www.chipdip.ru/product/lm2937imp-5.0-nopb>
10. JSC "Specialized electronic systems" (SPELS) [electronic resource] URL: <http://www.spels.ru>
11. Ultra Low Dropout Positive Fixed Linear Regulator IRUH33P253A1M [electronic resource] URL: <https://www.irf.com/product-info/datasheets/data/iruh33p253a1m.pdf>
12. Derbunov I. V., Bryukhno N. A., Dantsev O. O., Kulchenkov E. A., Rybalka S. B. and Demidov A. A., in Proc. of Sci. Conf. on Electronic Component Base and Microelectronic Modules Russian forum Microelectronics 2023. Sochi, 2023, pp. 275–276 [in Russian].
13. Khalaphyan A. A., STATISTICA 6. Statistical data analysis, Moscow, Binom-Press, 2007 [in Russian].
14. STATISTICA [electronic resource] URL: <http://statsoft.ru/>
15. Vukić V. Dj., in Proc. 6th International Conference on Electrical, Electronic and Computing Engineering, Srebrno Jezero, 2019, pp. 695–700.
16. Rashid M. H., SPICE for Power Electronics and Electric Power, Boca Raton-London-New York, CRC Press, 2017.
17. LTspice Simulator | Analog Devices [electronic resource] URL: <https://www.analog.com/en/design-center/design-tools-and-calculators/ltspice-simulator.html>
18. May C., Passive Circuit Analysis with LTspice®: An Interactive Approach, Cham, Springer Nature Switzerland AG, 2020.