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Experimental study of resistance of the integrated microcircuit of differential voltage comparator to ionizing radiation

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Abstract. The results of the study of comparator IS-K1 and its foreign analogue TL331 for its hardness to ionizing radiation (IR) effect are presented. It is established that no thyristor effect found in the studied IR range.

Keywords: comparator, ionizing radiation, total ionizing dose effects.

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Introduction

Features of the design implementation of modern integrated microcircuits with a medium and high degree of integration determine the complicated nature of their radiation behavior under the influence of IR, in particular, by the effects of the total ionized dose and dose rate. Modern trends of miniaturization of the electronic base components impose its limitations during integrated microcircuits developing process and may increase the risk of generating, for example, the thyristor effect [1]. In this context, the goal of developing methods for determining the radiation hardness factors of the electronic base components, in particular, the IS-K1 comparator (foreign analogue of TL331), studied in this work, is important.

Materials and Methods

The integrated microcircuit of the IS-K1 voltage differential comparator in SOT-23-5 metal-polymeric package were manufactured by JSC "GRUPPA KREMNY EL" [2]. The total ionizing dose effects in the IS-K1 and its analogue TL331 [3] were studied using the X-ray complex RIK-0401: anode voltage – 70 kV, anode current – 200 μA, the radiation absorbed dose rate was 297 un./s (un. – units of the DRI-0401 comparator). For study IS-K1 and TL331 to hardness of pulsed IR effect was used RADON-23 laser complex: the wavelength – 1064 nm; the radiation pulse energy – 120 mJ; the effective pulse duration – 10 ns; the beam diameter – 11 mm. The RIK-0401 and RADON-23 complexes were integrated into the developed research complex with the necessary equipment and measuring modular (PXI) equipment and tested in the study of the radiation hardness of linear voltage regulators [4].

Results and Discussion

During X-ray irradiation, IS-K1 and its analogue TL331 were in an active electrical mode at supply voltage of 16 V and load current of 1 mA. Studies performed using RIK-0401 X-ray complex showed that the electrical parameters for IS-K1 and TL331 are close and both integrated circuits demonstrate radiation hardness in the total ionized dose range up to ~ 2300×10^3 un. During laser irradiation, IS-K1 and TL331 were in an active electrical mode: supply voltage of 15 V, reference voltage of 3V, input voltage of 2B, temperature of 20°C. Studies performed using RADON-23 laser complex showed that during the pulse of the IR there is operation interruption time of the IS-K1 and TL331 by the output voltage.

It was found that the thyristor effect is not observed in the studied samples IS-K1 and TL331 (see Fig. 1) both at a minimum energy density of 1 mJ/cm^2 (*a*, *c*) and at a maximum of 100 mJ/cm^2 (*b*, *d*). The interruption time of the IS-K1 operation was 8 μs (energy density - 1 mJ/cm^2) and 15 μs (energy density - 100 mJ/cm^2) correspondingly. Analogously, for TL331 the interruption time of operation was 5 μs (energy density - 1 mJ/cm^2) and 12 μs (energy density - 100 mJ/cm^2). Therefore, the registered interruption time values do not exceed the required parameters and the same values for IS-K1 are close to the measured values for the TL331.

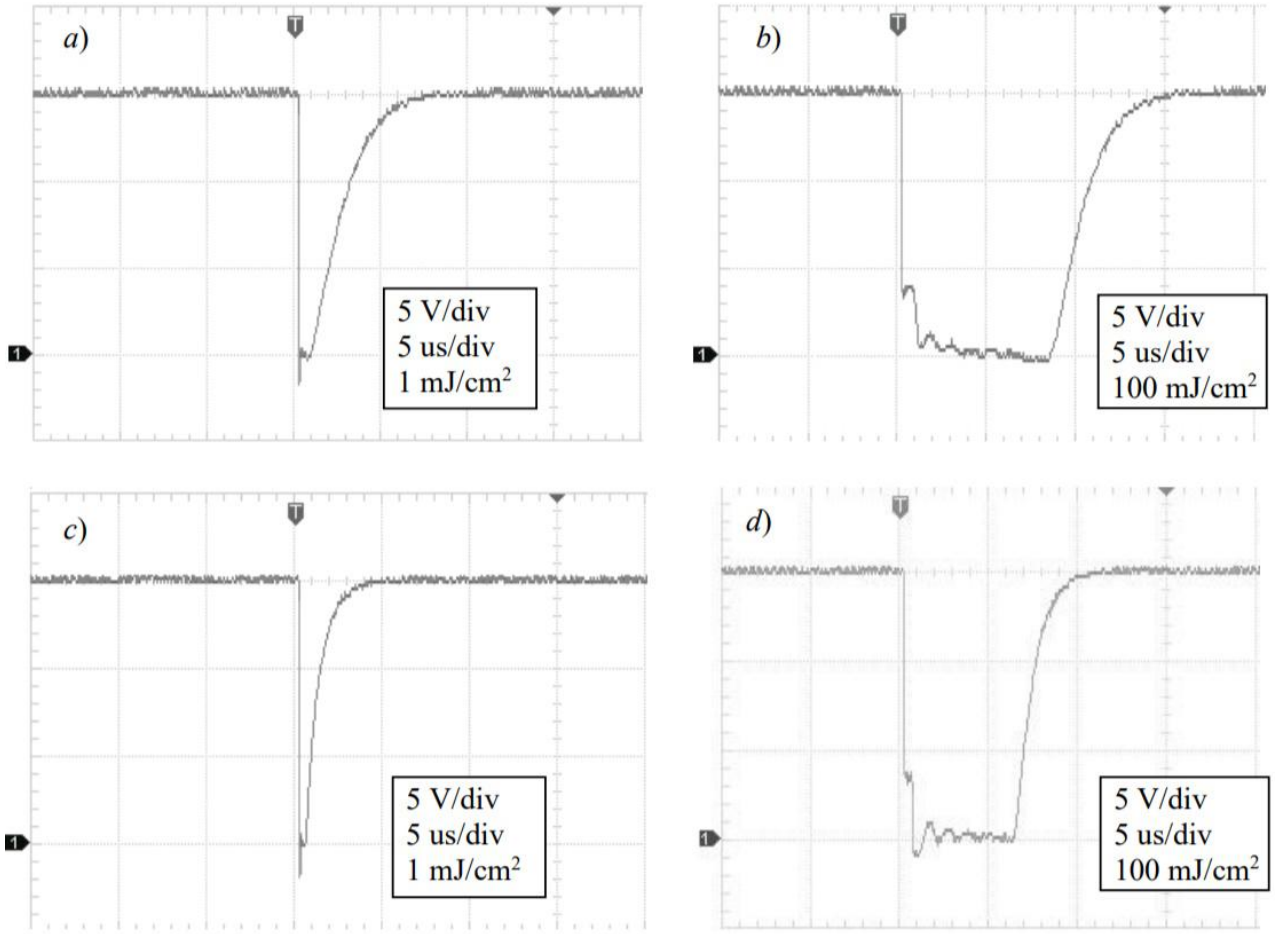

Fig. 1. The oscillograms of the IS-K1 (*a*, *b*) and TL331 (*c*, *d*) under the exposure of pulsed ionizing radiation (scale factor - 5 V/dev, 5 μs/dev) with energy density: *a*, *c* - 1 mJ/cm^2; *b*, *d* - 100 mJ/cm^2.

Conclusion

Thus, the used method for determining the radiation hardness indicators of the IS-K1 comparator in SOT-23-5 metal-polymeric package and its foreign analogue TL331 made it possible to diagnose the presence of ionizing radiation sensitive parameters. It was established that no thyristor effect found for comparators in the studied ionizing radiation interval.

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REFERENCES

1. **Chumakov A. I.**, Radiation hardness of electronic components base products, NIYAU MIFI, Moscow, 2015.

2. JSC «GRUPPA KREMNY EL». URL: https://group-kremny.ru. Accessed Mar. 30, 2025.

3. Comparator, Single Channel, Open Collector, Low Power, Wide Supply Range TL331, TL331V, ONSEMI. URL: https://www.onsemi.com/pdf/datasheet/tl331-d.pdf. Accessed Mar. 30, 2025.

4. **Rybalka S. B., Demidov A. A., Kulchenkov E. A., Pilipenko K. S.,** Radiation behaviour study of linear voltage regulator, St. Petersburg State Polytechnical University Journal: Physics and Mathematics. 3.1 (17) (2024) 195–198.