SYSTEM OF DIAGNOSTICS OF TECHNICAL CONDITION OF NANOSIZED ELECTRICAL SYSTEMS

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The development of nanoelectronics associated with the advent of transistors and other elements with characteristic topological dimensions of less than 100 nanometers, foreshadows the emergence of complex electrical nanosystems [1]. When designing any electrical system is always a question of its safety. Nano-sized electrical systems will also be subject to the occurrence of failures in them associated with short circuits and breaks in conductive channels.

One of the latest developments to ensure the safety of electrical circuits is electric network protection automatic (gas stations). Such a protective device is necessary in any electrical circuit, as it protects against various emergency situations [2]. The operation of such machines is associated with electromagnetic and thermal processes occurring in them. The implementation of gas stations operating according to generally accepted principles in nanoscale systems is currently not possible.

Using the apparatus of Boolean functions and transistor - transistor logic (TTL) [3], a system for determining failures of a nanoscale electrical system and an algorithm for its operation can be quite simply constructed.

In determining the diagnostic features of the technical state, it was taken into account that all disturbances in the nano-sized electrical system can only be associated with failures in its elements. Therefore, this condition is necessary and sufficient to address the issue of system performance.

To diagnose the state of the system is determined by the minimum set of diagnostic features. For this purpose, a diagnostic matrix of the system states is compiled, which provides the possibility of solving the diagnostic problem with the required accuracy. The main diagnostic signs of the main malfunctions of the system such as a short circuit and (or) break of the conductive channel are the expressions:

$$X_1 = \begin{cases} 1, \dfrac{dU}{dt} > 0; \\ 0, \dfrac{dU}{dt} = 0; \end{cases} \quad X_2 = \begin{cases} 1, \ \dfrac{dI}{dt} > 0; \\ 0, \dfrac{dI}{dt} = 0. \end{cases}$$

To simplify the synthesis of the optimal algorithm of the system for detecting failures from unacceptable voltage deviations due to the occurrence of states, the initial diagnostic matrix is transformed: indistinguishable states are combined in each of the groups that characterize the technical condition of the system. The simplified state table is a logic diagram of the failure detection system.

The possibility of implementing the simplest AND-OR logic elements on field-effect transistors makes it possible to build a non-spinning protection system for electrical nano-sized AC systems.

The elements for the protection system are silicon MDP – nanotransistors manufactured according to the technology "silicon on dielectric" (KND). This technology is considered by all leading electronic firms in the world as the basis for creating ultra-high-speed systems operating in the frequency ranges of tens and even hundreds of GHz at a supply voltage of a fraction of a volt. To create such structures, currently in industry widely used technology "isolation hidden oxide" – SIMOX, which allows to obtain a deeper layer of dielectric (SiO_2) under the surface of silicon implantation of oxygen ions.

Thus, a system built on nanotransistors using TTL and a device of Boolean functions allows one to determine failures in nanoscale electrical systems.

References

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