SIMULATION OF THE COMPLEX IMPACT OF THERMAL AND SHOCK LOADS ON ELECTRONIC MODULES

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Abstract — A technique for the optimal design of electronic modules is proposed. At the same time, the methodology is based on the system principles of the analysis of complex systems, complex modeling of physical processes in electronic modules and finding optimal solutions.

1. Introduction

Electronic modules that are part of radio-electronic means during operation are subjected to destabilizing influences, which include thermal, mechanical and climatic factors. Most scientific research on the effects of shock or thermal loads on electronic products is aimed at obtaining data when only one type of load is applied. It seems expedient to consider the complex effects of mechanical and thermal effects. Three-dimensional modeling of the complex impact of thermal and shock loads is relevant [1, 2].

2. Main part

In most cases, electronic modules are installed in the housing, connectors are connected to them and, after assembly, a ready-made electronic device is obtained. Installation in a housing allows to reduce the risk of damage to electronic modules during operation of the device, protecting printed circuit boards with radio elements installed on them.

To carry out the simulation, a model of the generator control unit was selected. The control unit consists of four electronic modules: connection module, control module, display module, voltage converter module. Electronic modules are installed in an aluminum housing.

To reduce the requirements for computing power of the computer during simulation, the original model of the generator control unit shown in Figure 1 was simplified. The simplified model mostly consists of elements of simpler geometry, perhaps the original, simplified model is shown in Figure 2.

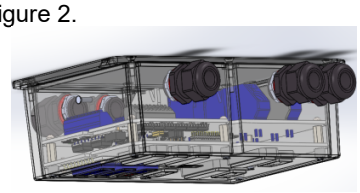

Fig. 1

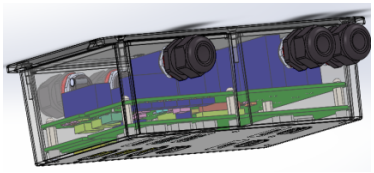

Fig. 2

The ANSYS software was chosen for the simulation. It allows you to use the results of thermal modeling when simulating the effect of mechanical loads, thus modeling the complex effect of thermal and shock loads on the device under study is achieved. Thermal and mechanical modeling uses the same engineering data (material data) and the same geometric model.

An important aspect of this modeling is the designation of the materials of the elements that make up the model. The following materials were selected for the simplified model of the device: case — aluminum, fasteners — steel, ceramic capacitors and resistors — ceramics, material for microcircuits, diodes in plastic cases — plastic, PCB material — FR4.

In the first case, an impact load of 150 N is applied to the side face of the body in 0.1 s. The temperature of the entire model is taken equal to + 20^{0}C.

The effect of shock loading on devices with a uniform temperature is shown in Figure 3.

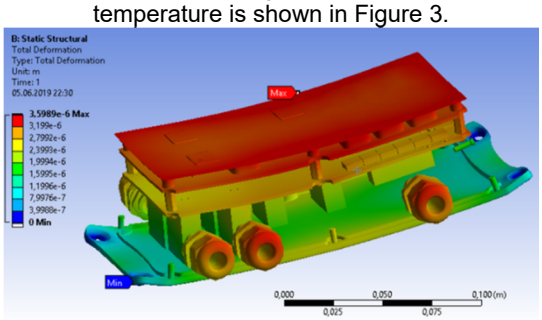

Fig. 3

By analogy, the authors carried out studies for thermal and shock loads with different values of destabilizing factors.

3. Conclusion

Criteria have been formed for obtaining initial information when carrying out mathematical modeling of the effect of heat and shock loads on electronic modules.

4. References

[1] The Impact of ESD on Microcontrollers / G. A. Piskun [et. al.] ; edited by V. F. Alexeev. — Minsk : Kolorgrad, 2018. — 184 p.

[2] Алексеев, В. Ф. Моделирование тепловых полей электронных систем в среде ANSYS / В. Ф. Алексеев, Д. В. Лихачевский, Г. А. Пискун // BIG DATA and Advanced Analytics = BIG DATA и анализ высокого уровня: сб. матер. VI Междунар. науч.-практ. конф., Минск, 20—21 мая 2020 г. ; в 3 ч. — Минск : Бестпринт, 2020. — Ч. 3. — С. 282—286.

МОДЕЛИРОВАНИЕ КОМПЛЕКСНОГО ВОЗДЕЙСТВИЯ ТЕПЛОВЫХ И УДАРНЫХ НАГРУЗОК НА ЭЛЕКТРОННЫЕ МОДУЛИ

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Аннотация — Предложена методика оптимального проектирования электронных модулей. При этом в основе методики лежат системные принципы анализа сложных систем, комплексного моделирования физических процессов в электронных модулях и нахождения оптимальных решений.