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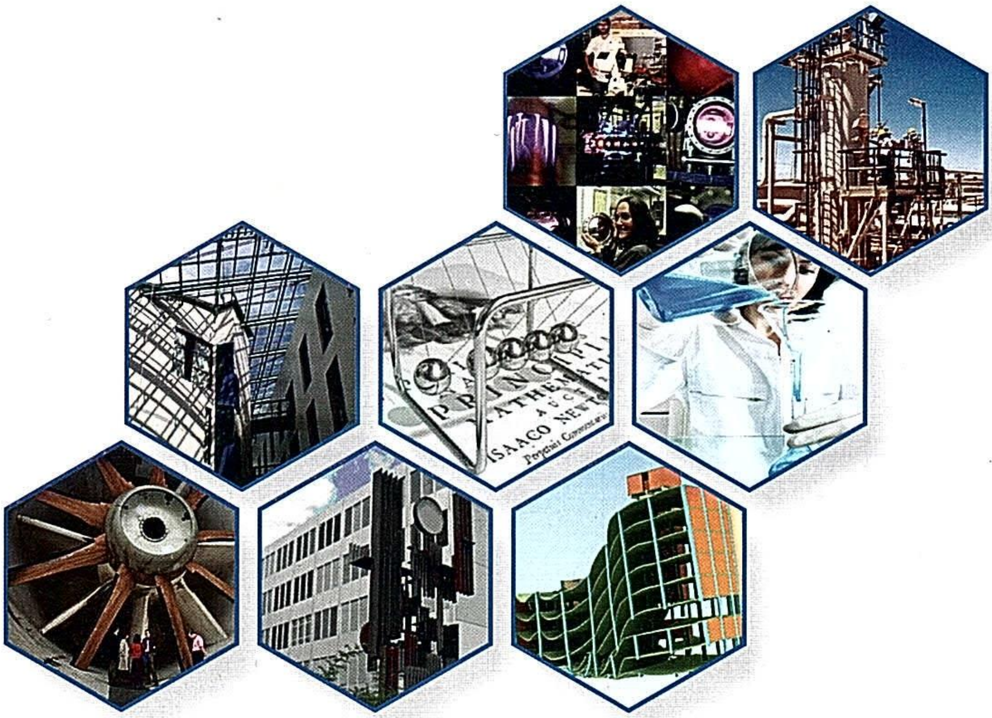

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A Method of Ensuring Controllability of Electronics Based on Diagnostic Modeling of Heterogeneous Physical Processes

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Abstract: The paper discusses the basic operations to ensure testability of electronic means (EM). The result of the proposed transactions is the basis of the diagnostic data. To improve the efficiency of the diagnostic modeling of the underlying testability design, the processes of calculation of tolerance limits and creation a list of possible defects are considered. Allocated a distinguishing feature of the proposed method, which consists in taking into account the thermal characteristics for electrical diagnostic modeling. The technique of checking the uniqueness of detection considered defects. And a criterion for evaluation of the achieved level of testability is also proposed.

Key words: Electronic means · Computer-aided design · Life cycle · Testability · Diagnostic modeling · Test action · The reject limit of tolerance electronic radio element

INTRODUCTION

Increasing requirements for functionality of advanced electronic equipment (EM) cause a continuous increase in their complexity. Traditional design methods based on the individual circuit prototyping and design solutions can not provide the proper quality of the projects. So innovative information technologies, based on the extensive use of mathematical modeling with the use of computers, are implemented everywhere.

However, the latest tools and techniques of design and technological preparation of production of electronics do not allow properly ensure testability EM [1,2]. To the greatest extent it relates to the analog devices. Engineer, first of all, seeks to fulfill the basic requirements imposed on the equipment and often do not pay enough attention to diagnosis, thus the process condition monitoring and troubleshooting becomes more difficult and costly and in some cases problematic. Naturally, that eventually, despite the widespread use of CAD / CAM / PDM-systems, this leads to insufficiently high efficiency lifecycle EM organization entirely.

To solve the problem of timely fault detection, aided design method of testability EM, based on the diagnostic modeling of heterogeneous physical processes regarding the defined fullness and depth of testing to check the removable element (Pic. 1) is proposed.

For providing an effective diagnostic modeling first of all it is necessary to determine a list of typical defects, to form a set of researching electronic radio elements (ERE) and a list of test actions and to calculate tolerance limits on the parameters of ERE.

The procedure of forming diagnosed ERE sets and formation processes of test actions are discussed in details in [3,4] and [5] respectively.

The principle of the diagnostic modeling lies in entering the changes, that characterize a specific defect, into a model with nominal parameters. The mathematical model of electric circuit of EM in the nominal mode can be presented as:

$$\overline{F}(\overline{u},\overline{u}',t)=0,$$

where $\overline{F}$ -nonlinear vector function;

$\overline{u}=f(\overline{q})$ -vector of nodal potentials;

$\overline{u}'=f'(\overline{q})$ -vector of differential nodal potentials;

t-time;

$\overline{q}$ -vector of internal circuit parameters.

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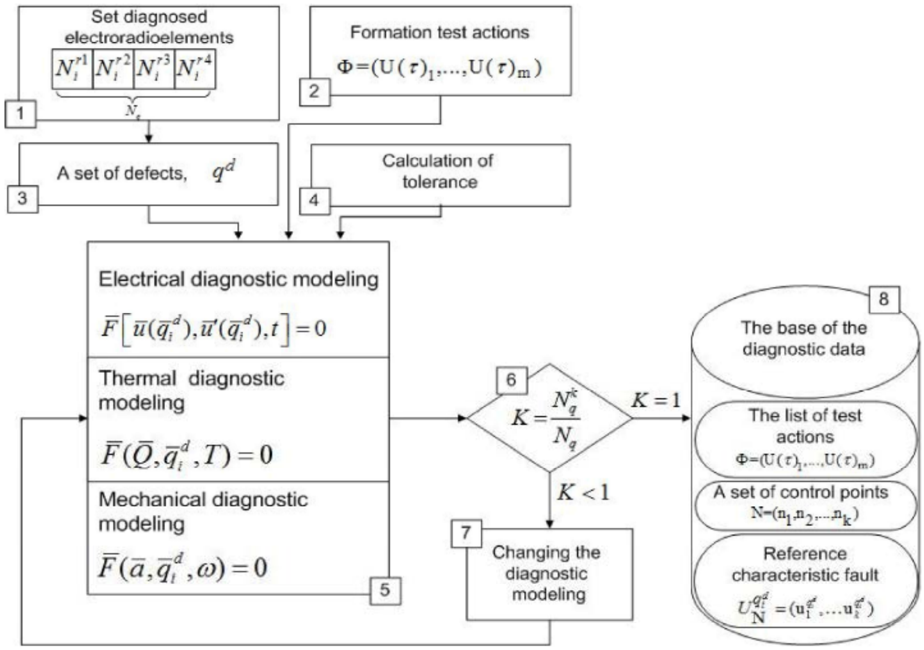


Pic. 1: A block diagram of the ensuring controllability of electronic means method

Table 1: Types of ERE defects

Types of defects influencing the		
electrical characteristics	thermal characteristics	mechanical characteristics
- wire break;	- lack of thermal paste between the components;	- Cracks in the printed circuit board;
- deviation from ERE parameter's nominal value;	- random contacts with other ERE;	- The presence of foreign objects on the circuit board;
- shorted wires;	- Displacement of ERE;	- Debilitated mount;
- thinning of the conductors;	- Unsuitable radiator;;	-Detachment of conductors;;
- poor conductor's contact connections	- Poor contact with the heat sink;	- Displacement of ERE

Table 2: ERE failure statistics by type,%

ERE	Short circuit	Breakdown	Breakage	Parameters deviation from the normal value
Diodes	15	5	15	65
Transistors	10	5	15	70
Capacitors	60		5	35
Resistors	25			75

In this case diagnostic model takes form:

$$\bar{F}\left[\bar{u}\left(\bar{q}_i^d\right),\bar{u}\left(\bar{q}_i^d\right),t\right]=0,$$

where $\bar{q}_i^d$ -internal circuit parameters with entered *i*-th defect.

The list of defects formed strictly for recruitment diagnosed elements. In this case, the defects can be detected as a method of diagnosis and more. For example, ERE breakage can be detected as electrical methods of diagnosis, due to potential changes in the control points and as vibration and acoustic methods, due to changes in the amplitude-frequency characteristic (AFC), or create a "bounce", which appears in the acoustic analysis. Thus, the defects can be separated in terms of impact on the relevant characteristics of ERE.

Some types of defects considered under this method are shown in Table 1.

One of the factors, that affects on the results reliability from diagnostic simulation, is the error of modeling and diagnosis accounting, which is determined by the error of means of control and diagnosis. Thus, the condition is met for defects that lead to significant changes in the characteristics:

$$\Delta Q = \Delta \mathrm{mod}\,el + \Delta measure$$

where $\Delta Q =$ |*Q(*serviceable element*)–Q(*defective element*)*|, Δ model-simulation error of physical processes in EM, Δ measure-error of means of measurement.

Using the analysis of types and causes of defects, was obtained ERE failure statistics. An example of failure statistics affecting the change in the electrical characteristics is given in Table 2.

A distinctive feature of the method is accounting the temperature during electrical diagnostic modeling. Where T-ERE temperature.

The classical method for the diagnostic computer simulation does not take into account the mutual thermal and electrical processes. As a result, to solve problems of diagnosing heat-loaded EM the quality of modeling had reduced, which led to an increase of probability of obtaining an incorrect diagnosis [6].

This is explained by the fact that in the scattering of energy the temperature of components differs from the ambient temperature and the nominal temperature at which the reference ERE values are leaded. As a result, the internal parameters of active and passive elements change.

$$R = R_0\,(1+\alpha_R\,(T-T_0)),$$

where *R*-current value of the resistor,

- R_0 — resistance *at* T_0,
- α_R — temperature coefficient of resistance,
- T — calculated resistor's temperature,
- T_0 — normal temperature.

For example, with increasing temperature relative to 200C, increases the resistance of metallic resistance materials and decreases the resistance of semiconductor materials and dielectrics, capacitor dielectric strength decreases, increase losses on the magnetization reversal in magnetic materials, shape factor of deteriorating materials with rectangular hysteresis loop, decrease residual values and the maximum magnetic induction.

Changing the ERE, leads to changes in the values of voltages and currents in the electrical circuit and, consequently, to changes in heat capacity.

To improve the quality of simulation of electrical circuits in the electrical model are entered parameters, depending on the temperature and in the model of thermal processes are introduced dependent power sources that allow to take into account the change in heat capacity.

The value of each parameter ERE varies within admission process according to the specifications. That means that for each j parameter q_j is the interval in which the parameter may be active;

$$q_j \in [q_j^l, q_j^h]$$

where q_j^h -upper and q_j^l -lower specification limits

Under the influence of destabilizing factors internal parameters of component elements are changed and may extend beyond the manufacturing tolerances, resulting the loss of working state because its output characteristic will be outside the specified tolerances. Destabilizing factors may be the temperature of the components elements and environment, aging elements, humidity and other phenomena arising in the operation of equipment [7].

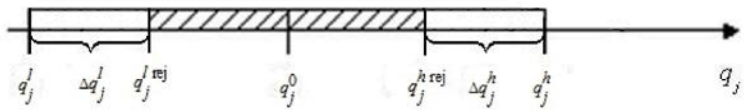
Thus, there is a task of calculating the tolerance limits, taking into account the influence of destabilizing factors arising in the operation of EM. As a result of calculation and ensure limit tolerances of device, guaranteed its working state.

The calculation of the reject tolerance is : suppose that on the nominal value of the *j*-th internal parameter of $q_j^{???}$ component was specified manufacturing tolerance $[q_j^l, q_j^h]$. During operation under the destabilizing factors $\overline{z}$ value of the j-th parameter is changed on $\Delta q_j = f(\overline{z})$. Denote increase and decrease of j-th parameter during operation of the device Δq_j^l and Δq_j^h. Values of the upper q_j^h rej and lower q_j^l rej reject tolerances will be equal.

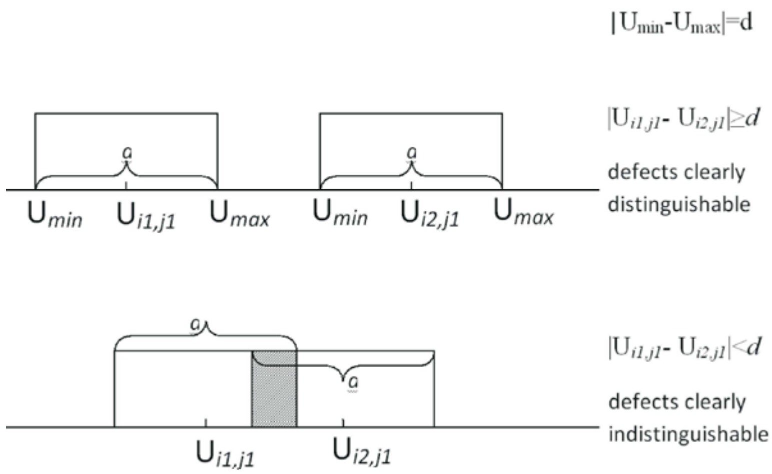
$$q_j^{l\ \mathrm{rej}} = q_j^l + \Delta q_j^l$$

$$q_j^0 = q_j^h - \Delta q_j^h$$

Graphical representation of the tolerances given in the 2-nd picture.



Pic. 2: Graphical representation of the tolerances



Pic. 3: Identifying differences between defects

Calculation changes in values of the *j*-th internal parameter $\Delta q_j(\overline{z})$ is performed:

- Conducted electrical simulation of the concept of electronic means for the purpose of determining the heat capacities of component elements.
- At a predetermined temperature range thermal modeling of print joint is held based on the results of electrical simulation to determine the maximum and minimum temperatures of elements [8].
- Calculate the changes of the *i*-th parameter under the influence of temperature Δq_j^T :

$$\Delta q_j^T = \alpha \cdot q_j \cdot \Delta T ,$$

where α-temperature coefficient, ΔT-temperature changes

- Depending on the useful life of electronic means changes of the parameter are calculated according Δq_j^t ,

$$\Delta q_j^t = \beta \cdot q_j \cdot t$$

where β-the aging factor, *t*-time operation. Depending on the design and number of factors in calculating may be used the nonlinear model of aging.

- Calculation of parameter changes under the influence of other destabilizing factors (aging, vibration, pressure, etc.) encountered during operation in predetermined conditions.
- Calculation of parameter changes under the influence of all destabilizing factors as sum of parameter changes under the influence of any one factor.

As a result of the diagnostic modeling diagnostic electronic manual based on tolerances on the ERE is formed for a specific list of defects. Each simulated defect corresponds value of the output characteristics. Using this feature on diagnosis or monitoring stage and comparing it with received modified dates corresponding defect is identified. Also on the forming stage of the directory defective characteristics are compared with the nominal values. When comparing characteristics of the defect with the nominal or measured there could be a problem of sure distinctiveness of defects.

Diagnostic electronic manual is like a spreadsheet, where in cells there are the values of the output characteristics associated with different defects. The values contained in the guide of faults, are the amount of ideal values and modeling uncertainty:

$$U_{\text{calculat}} = U_{ideal} + \Delta U_{\text{mod}\,el}$$

It should be consider that diagnostic electronic manual will be used in the diagnosis by comparing measured and calculated characteristics. Means of measuring have calculating uncertainty, which must be taken into account when it is necessary to identify clearly detected defect.

Thus, must be carried the inequality for the clear identification of defect

$$(U_{i1} - U_{j1}) > d$$

where I, j-types of defects, $d = \Delta_{\text{mod}} + \Delta_{izm}$, Δ_{mod} - modeling uncertainty, Δ_{izm} -uncertainty of measurement.

Comparison of characteristics derived from the diagnostic modeling with nominal characteristics allows to judge extent of controllability.

Ensuring testability criterion is the coefficient of controllability:

$$K = \frac{N_q^k}{N_q},$$

where *K*-coefficient of controllability; N_q^k -list of clearly detectable defects.

The level of testability is the ratio of the number of uniquely identified defects to their total number.

The K value equal to 1 means that the product is traceable and all the defects of the list are uniquely identified using the generated electronic diagnostic manual.

In the case of non-compliance by controllability, it can be said that not all defects from the under consideration list is uniquely distinguishable. The solution of this problem is possible by the use of complex techniques of electrical, thermal and vibration and acoustic diagnostics. The defect's ambiguity, for example, by analyzing the electrical characteristics, can be solved by applying a thermal diagnosis. Assigning additional control points and supply of input signals different from the nominal also contributes to solving the defects ambiguity problem and, consequently, ensuring controllability.

As a result of operations to ensure controllability the base of the diagnostic data, which contains a list of test actions for different modes of EM is formed and a set of effective control points [9], allowing uniquely distinguish between defects and faults typical reference [10] is also formed.

The use of database of diagnostic data on the stage of output control and operation stage can increase the efficiency of monitoring and diagnosing to 40%, in turn, by reducing the timelines and improving the reliability of these processes.

The results of the project "Development of methodology for computer-aided reliable design of electronic of remote monitoring of distributed systems", carried out within the framework of the Basic Research Program at the National Research University Higher School of Economics in 2013, are presented in this work.

REFERENCES

1. Uvaysov, U.S., I.A. Ivanov and R.I. Uvaysov, 2008. Indicators testability of electronic equipment //The world measurements. Number three, pp: 47-51.
2. Uvaysov, U.S.I.A. Ivanov, 2011. Information model of the design process traceable electronic means / / Information Technology, 12: 41-45.
3. Uvaysov, U.S. and I.A. Ivanov, 2011. Ensuring testability of electronics in the framework of CALS-technologies // Quality. Innovation. Education, 1: 43-46.
4. Uvaysov, S.U. and I.A. Ivanov, 2011. Synthesis of the set for diagnosis of significant component elements res. Innovation is based on information and communication technologies, 1: 252-255.
5. Ivanov, I.A., U.S. Uvaysov and N.A. Koshelev, 2011. Forming sets of test signals for controlling the quality of electronic spacecraft // Quality. Innovation. Education, 11: 84-88.
6. Maslennikova, J.L., I.A. Ivanov, R.I. Uvaysov and V.E. Eremina, 2011. Higher reliability of the thermal regime elements printed circuit assemblies. Proceedings of the International Symposium reliability and quality, 2: 397-398.
7. Uvaysov, S., L. Ageeva and M. Caloev, 2012. Experimental studies of the possibility of compensating the temperature errors due to thermal sensor-contact method of control of thermal conditions of electronic / / In.: Reliability and Quality 2012: proceedings of the International Symposium: 2 Vols / Ed. Ed.: NK Jurkov.. T. 2. Penza: Penza State University, pp: 452-454.

8. Uvaysov, S., V. Eremina and A. Arestova, 2012. Simulation Monte Carlo method in the synthesis of tolerances on the parameters of passive components board space equipment // In.: Reliability and Quality 2012: proceedings of the International Symposium: a 2-t / Ed. Ed.: NK Jurkov.. T. 2. Penza: Penza State University, pp: 445-447.
9. Ivanov, I.A., A.V. Kozyrev and R.I. Uvaysov, 2009. Method of selection of control points in electrical circuits radio electronic parts. Proceedings of the International Symposium reliability and quality, 2: 77-77.
10. Uvaysov, U.S., I.A. Ivanov and A.E. Abrameshin, 2012. Testability design of the secondary sources of supply with relay control / / In.: Reliability and Quality 2012: proceedings of the International Symposium: in 2 volumes / Ed. Ed.: NK Jurkov.. T. 2. Penza: Penza State University, pp: 457-459.