Providing of Parametric Reliability of REA on the Stage of Production

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Abstract - **The task of providing of parametric reliability of radio electronic apparatus (REA), which would guarantee finding of initial parameters of products in the set limits during the period of exploitation is solved in this paper.**

Keywords - **REA, reliability, forecast.**

INTRODUCTION

The problem of quality management and, in particular, reliability of precise radio electronic apparatus (PREA), became one of major problems of development of this technique lately. It is predefined mainly by its complication and growth of responsibility for efficiency of implementation of the functions by devices.

MAIN PART

Every technical object is characterized by a group or plurality of properties which determine its quality in obedience to destination. Properties, not connected with destination, are considered such which do not influence on its quality. Every property can be numerically described with the help of some variable, the concrete value of which characterize the quality of experimental object in relation to this property. This variable is named a property index. Based on this, it is possible to consider that an index of quality of object is a vector the components of which are indexes of its properties. The task of providing of such properties of products, which would guarantee finding of input parameters in the set limits during the certain period of exploitation, appears in the process of production of precise apparatus. Thus the production objects should be considered as dynamic systems with random values of parameters. Ensuring their properties is estimated by the probability of task execution $P_{вз}$, which is written as a condition:

$$P_{вз} = P(X(t) \in \{X_{доп}\}/X(t=0) \in \{X^{в}_{доп}\}),\ \forall t =[0,T_{гар}], \quad (1)$$

where $X_{доп} = \{\Delta_1\text{-}\Delta_2\}$; Δ_1, Δ_2 – exploitation tolerance limits. $X^{в}_{доп} = \{\Delta^{в}_1\text{-}\Delta^{в}_2\}$; $\Delta^{в}_1$, $\Delta^{в}_2$ – production tolerance limits.

Each event that determines the possibility of execution of a task is characterized by appropriate probability:

$$P_{п} = P(X(t) \in \{X_{доп}\});\ t=[0,T_{гар}], \quad (2)$$

- probability, that defines the parametric reliability of product;

$$P_{т} = P(X(t=0) \in \{X^{в}_{доп}\}), \quad (3)$$

- probability, that defines accuracy of the process of formation parameter x during manufacture of the product.

$$P_{п} = \int_{0}^{T_{гар}} \int_{\Delta_1}^{\Delta_2} f(X,t)\,dx\,dt \ ; \quad P_{т} = \int_{\Delta_1}^{\Delta_2} f[X,(t=0)]\,dx, \quad (4)$$

where f(X,t) - two-dimensional distribution density of the source parameter x during product exploitation on interval from 0 to $T_{гар}$; f[X(t=0)] - distribution density of the original value after the process of its formation.

Parametric reliability estimated by probability that during functioning of the device T output parameters do not reach allowed limits:

$$P_{п} = P(X(t) \in \{X_{доп}\}) = P(\Delta_{11}<x_1(t)<\Delta_{12}, \Delta_{21}<x_2(t)<\Delta_{22}, \ldots, \Delta_{n1}<x_n(t)<\Delta_{n2}), \quad (5)$$

where $X(t) = [x_1(t), x_2(t), \ldots, x_n(t)]$ – the vector of device condition in n-dimensional phase space; $x_i(t)$, $i=\overline{1,n}$ - components of vector X – output parameters; Δ_{i1}, Δ_{i2}, $i=\overline{1,n}$ - allowed values of parameters– ordinates of limit states surface.

If distribution density of vector X is known, i.e. density of compatible distribution of parameters $x_1, x_2, \ldots, x_n$ - $f(x_1, x_2, \ldots, x_n/t \le T)$ at any moment of time $t \le T$, then parametric reliability will find the following:

$$P = \int \cdots \int_{X^{доп}} f(x_1, x_2, \ldots, x_n / t \le T)\,dx_1 dx_2 \ldots dx_n, \quad (6)$$

where $\{X^{доп}\}$ – area of allowed values of output parameters.
In general form, the density distribution of the vector X determined by the formula

$$f(x_1, x_2, \ldots, x_n / t \le T) = f(\psi_1, \psi_1, \ldots, \psi_n) \left| \frac{\partial(\psi_1, \psi_1, \ldots, \psi_n)}{\partial(x_1, x_1, \ldots, x_n)} \right|, \quad (7)$$

where $\left| \frac{\partial(\psi_1, \psi_1, \ldots, \psi_n)}{\partial(x_1, x_1, \ldots, x_n)} \right|$ - yakobian display functions $\psi_i = \psi_i(X)$.

Defining of parametric reliability using the above formulas is possible only under condition of their simplicity to the complexity of devices. Under large quantity of output parameters, density distribution $f(x_1, x_2, \ldots, x_n/t \le T)$ defined ambiguous, and that's why the calculation of parametric reliability of products, which are really characterized by tens of output parameters, even in fixed time moments, is practically impossible.

The accuracy of forecasting parametric reliability of products is determined by many factors that caused by accurate mathematical model of process of parameter drift during operation and the accuracy of method of its forecasting.

CONCLUSION

Among the known methods of providing parametric reliability on the production stage, important place is taken by method, based on normalization error parameters by applying on them the optimal production limits. The choice of method of defining of production limits is based on principles of group or individual forecast.

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