Tolerance Design and Electronics Elements' Selection under External Influences

Galina Shilo, Daria Kovalenko, Mykola Gaponenko

Abstract – **Peculiarities of tolerance region forming are being considered taking into account external influences under normal distribution law. Algorithms of tolerance design under given parameters and external factors have been submitted. Relations for elements selection providing costs minimization were taken. Element selection methods are suggested subject to specialties of electronics elements.**

Keywords – **Ellipsoidal tolerance region, operability region, external influences, iteration algorithms.**

I. INTRODUCTION

One of substantial problems of the radio-electronic devices design is assurance of given accuracy that is characterized by deviations of elements' parameters which consist of manufacturing deviations and deviations produced by external factors influences during an operating process and materials aging [1]. Maintenance of required accuracy is assured by selection of suitable parameters of elements including tolerances and external influences coefficients. Developments of accuracy assurance methods were carried out by native and foreign scholars A.V. Mihailov, K.S. Savin, A.V. Fomin, L.A. Nedostup, M. Dyvak, Kolev L.V., Spence R.

Geometric methods where tolerance regions were formed by interval models of output function in tangent points of tolerance regions and operability region allow obtaining high accuracy of tolerance assignment but external factors were taken into account only for interval distribution of parameters [2]. Cost minimization problem under external influences was solved in interval tolerance selection methods [3].

The objective of this paper is to design the methods of tolerance assignment and element selection under the normal distribution law taking into account external influences and cost characteristics of electronics' elements. For the solution of the formulated problem it is necessary to develop methods of tolerance region forming under normal distribution law and external influences; to develop tolerance design methods with given parameters of elements; to consider peculiarities of cost characteristics; to develop algorithms of tolerance and external factor coefficients selection with cost minimization of devices; to develop methods of element selection subject to peculiarities of electronics' elements.

II. TOLERANCE DESIGN UNDER GIVEN PARAMETERS OF ELEMENTS

External influences change location of ellipsoidal tolerance regions formed under normal distribution. Boundary values of output functions are taken by equations which defined under the most unfavorable external factors combination.

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A tolerance assignment under given boundary of operability region, coefficients and variation bands of external influences is carried out with mapping method. Boundaries of operability region can be specified as a one-sided limit value or values interval of output function during device operating. Iteration algorithms allow taking into account nonlinearity of output functions.

III. ELEMENTS PARAMETERS SELECTION SUBJECT TO COST CHARACTERISTIC

Under external influences cost dependence is formed as set of characteristics which location are defined with coefficients and variation interval of external influences. The characteristics are formed for every element taking into consideration given list of parameters and operating conditions. Power function is the most approximate to cost characteristics. Equations for optimal cost parameter deviations were taken using power models of cost dependency. The equations were utilized in iteration algorithms of elements parameter selection under given boundary values or deviation width of the output function.

Additional optimization criteria of equal tolerances or maximal volume of tolerance region can be used in algorithms. Restricted values of electronics elements parameters are taken into consideration in the algorithms. Standard tolerance selection is assigned with ranking by cost relative deviations from its values of given characteristics.

IV CONCLUSIONS

Tolerance regions forming under normal distribution law of parameters was considered. Algorithms of tolerance design under given external influences coefficients were developed subject to the most unfavorable external factor combination.

Investigation of cost characteristics showed that for every element set of characteristics is formed under different values of coefficients and variation bands of external influences. Methods of elements selection with cost optimization were developed for one-sided and two-sided limiting of output functions. Algorithms allow to assign standard tolerances and takes into account electronics elements constrains..

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