

Research on the Electronic Circuits Reliability Tolerance Analysis Method and Its Application

Yonghong Fan, Na Li, Jianguo Zhang

¹Qingdao Huanghai University, Qingdao, Shandong, China

^a fanyonghong_618@163.com

Keywords: Electronic Circuits, Reliability, Tolerance Analysis Method

Abstract. In the electronic circuit system design process, tolerance analysis is the basis for reliability design. And it is also the most advanced design technology representing an important development direction in this field currently. In this paper, electronic circuits reliability tolerance analysis method was studied in process of electronic circuit system design, and also the application of the design was discussed. The study shows that tolerance analysis and fault diagnosis is a set of scientific and modern theory and technology and could be widely used in electronic circuit system design and reliability tolerance analysis.

Introduction

Electronics in military defense, aerospace technology, industrial automation, vehicle electronics and other fields are widely used in various electronic systems which directly affect the reliability of the electronic system reliability. Electronic circuit is composed of a large number of electronic components, electronic components parameters influenced by environmental factors, and fluctuations in the actual work, such as environmental temperature changes, the dispersion process and other factors will make electronic components the actual work values deviate from the nominal value, causing the entire performance of electronic circuits and electronic systems to malfunction. If the deviation performance and design of electronic circuits between the requirements within the tolerance range, the electronic circuit can still work properly, otherwise it will lead to failure of the electronic circuit (soft faults and hard faults). At very high reliability and stability of electronics applications such as satellite components in electronic circuits parameters have a small fluctuation may have unpredictable consequences. Therefore, the study of electronic circuits Reliability Tolerance Analysis Method has important theoretical significance and practical value to ensure system reliability and stability.

The Overview on Electronic Circuit Reliability Tolerance Analysis Methods

Tolerance refers to the permissible limit function: Obviously, anti-jamming design of the system is also inside, in a subsequent intervention process, the need for circuit design in the form of timely attention. In line subsequent intervention process, the application of electrical products and systems have a certain impact on the application form, you must attach importance to maximize the role of the existing form of intervention.

The Line Parameter Value Change. In the actual circuit control phase, often there will be a random number, in the subsequent design process, we must promptly to the original form of analysis, to analyze the existing forms of intervention, and ultimately determine a reasonable and effective numerical form. In addition the presence of circuit design and actual production forms a certain form of differences in the electronic application of the product, in the process of analyzing the line, we need to take into account the form of intervention according to the real situation.

Electronic Circuit Reliability Tolerance Analysis. Based on circuit design in the form of particularity, throughout the course of the intervention, according to the actual situation and take effective forms of analysis. Different forms of circuit design, design forms have different guiding significance in practice must be based on the actual situation, determine a reasonable and effective forms of intervention. In the subsequent development process, "using the control variable for

efficient Monte Carlo yield woo meter" in the Monte Carlo analysis in the form of clearly defined, marking the Monte Carlo analysis methods have matured. During the intervention, it can be combined in the form of specific design requirements, timely adjustment of the range, in addition to a range of forms of analysis, in the control phase takes full advantage of the error analysis in the form of requirements, timely analysis in the form of adjustments.

The Research Status of Tolerance Analysis Method

Tolerance refers to the permissible limit function: Obviously, anti-jamming system design also therein. Thus, with the increasing size of electronic circuits, the complexity of electrical products and systems, reliability tolerance design has been growing attention. In practice, the power electronics for each component parameters will deviate from its nominal rating, which constitutes the output characteristics of the system will therefore vary.

Monte Carlo analysis is a method of tolerance calculated using the theory of probability and statistics, is the late 1970s and early 1980s, proposed by. In 1977, Director S. W. et published a "simple approximation Design Center," a text, which is the earliest use of Monte Carlo method to estimate the yield of the literature. In 1981, Rankin D.J. published "by the control variables to effectively Monte Carlo yield estimate" article, marking the Monte Carlo analysis has matured. Rankin D.J. pointed out: tolerance calculation electronics Monte Carlo analysis is the most reliable method, this analysis method is suitable for any type of circuit, without the need for the device parameters, plus incentives, in the form of a circuit made simplifying assumptions. However, when using this method for large-scale circuit tolerance analysis, it takes a long time. Moreover, later we found in the actual work, the lower the use of Monte Carlo methods of tolerance analysis of the accuracy of the resulting interval smaller than the actual interval. Thus, it proposes a more effective method of analysis, that interval analysis method. Interval analysis method is caused by the finite word length computer research developed on the basis of the calculation error. In the late 1980s, Oppenheimer E.P. et al proposed interval analysis interval linear systems analysis techniques 5 6.

The Application of Tolerance Analysis Method in Electronic Circuits Reliability Analysis Form

Based on existing designs in the form of particularity, throughout the intervention process, the need for timely analysis in the form of effective analysis, combined with the existing forms of development requirements, to take reasonable and effective methods of analysis. The following will tolerance analysis method in reliability analysis of electronic circuits in the form of analysis.

Definition of Electronic Circuit Fault. In the subsequent analysis and system control process, based on the special nature of the type of fault, the need for timely and orderly conduct of the actual value analysis, to reduce the negative impact of adverse factors, thus achieving the desired control standards. In line overall application stage, in order to avoid the appearance of failure to promptly resolve the fault types, use of existing forms of control to maximize the role, reflecting the subsequent intervention in the form of advantage. Fault divided into hard and soft failures. Also known as a hard failure catastrophic failure of electric power electronic circuits short-circuited or open circuit, also known as soft faults deviate failure. In a specific control process, must promptly form of control on the tolerance analysis, combined with the existing design in the form of requirements, timely analysis of the composition of the device, and ultimately achieve the desired control points.

Master Control Standards. Current for electronic circuit design and application are clearly defined in the overall intervention process, must form the basis of inherent design, timely intervention in the form of the analysis, and determine the best form of control. Reliability and maintenance standards of electronic products in the intervention process and it must promptly analyze the tracking form and develop reasonable and effective form of obligation to play a role in maximizing the existing control mechanisms. According to the requirements of existing

interventions in the form of electronic product reliability requirements, in conjunction with the standard form, timely analyze.

The Reasonable Application of Control Forms. Simulation-based design in the form of particularity, throughout the intervention process, in order to achieve orderly form of intervention, we must form the basis of the existing design, structure and determine a reasonable extension of the original type. Because the circuit design itself has many problems, mainly with the original parameters and applying indicators have certain links in the follow-up process of intervention, the situation if there is deviation from the indicators, will inevitably affect the port design form, in a subsequent control stage, must be flexible application of known information, looking for the particularity of input forms, and analytical and numerical clear relationship between the original parameters. Typically between design forms and troubleshooting in the form of a certain line of contact, the application process in the test system must be directly on the line in the form of attention, and in fact, according to transistor design in the form of intervention in the form of requirements must be based on the temperature and humidity in the form of requirements, reasonable design analysis form.

The Simulation of Reliability Tolerance Analysis Using the Interval Analysis Method

Figure 1 shows a second order infinite gain multiple feedback band pass filter circuit and u_i is for sinusoidal input.

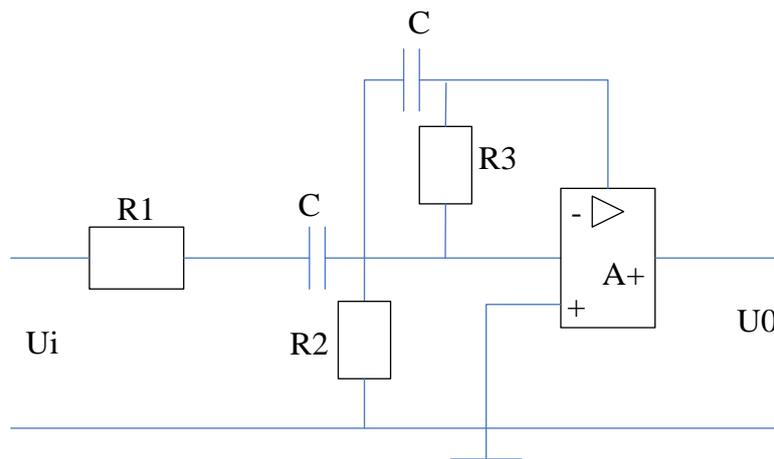


Fig. 1 Infinite gain multiple feedback band-pass filter circuit

Second order infinite gain multiple feedback bandpass filter circuit transfer function:

$$U_0(s) = \frac{GB_s}{s^2 + B_s + \omega_0^2} U_i(s) \quad (1)$$

According to the basic principles of interval analysis method by the formula (12) can be obtained second order made no gain multiple feedback filter circuit with tolerance output voltage, frequency and bandwidth through the formula is:

$$[U_0(s)] = \frac{[G][B]_s}{s^2 + [B]_s + \omega_0^2} U_i(s) \quad (2)$$

$$[f_0] = \frac{\sqrt{[R_1] + [R_2]}}{2\pi G \sqrt{[R_1][R_2][R_3]}} \quad (3)$$

$$[B] = \frac{1}{\pi[R_3]G} \quad (4)$$

By Equation (2), (3) and (4) the center frequency of the filter circuit can be obtained tolerance band is f_0 [204Hz, 249Hz], the tolerance band of bandwidth B [303.3 Hz, 335.2 Hz]. Second order infinite gain multiple feedback band-pass filter circuit ($u_i = 5\sqrt{2} \sin \omega t$) amplitude-frequency characteristic curve shown in Figure, curve 1 and section 2 of the interval between the analysis of the tolerance band in Figure 2.

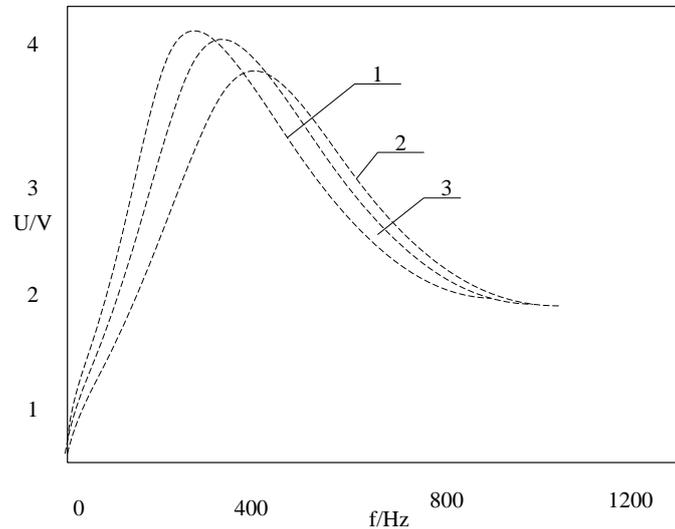


Fig. 2 Amplitude-frequency characteristics of Interval Analysis

- 1 - Tolerance Low amplitude-frequency characteristic curve ($R = 1.05k\Omega$)
- 2 - Tolerance High amplitude-frequency characteristic curve ($R = 0.95k\Omega$)
- 3 - nominal amplitude-frequency characteristic curve ($R = 1k\Omega$)

Conclusions

Electronic circuit reliability analysis and fault diagnosis of tolerance is a key technology for electric reliability study. Tolerance analysis and fault diagnosis is a set of mathematical statistics, interval mathematics, information science, systems theory, network theory, computer science as an integrated theory and technology, based on the design and practical form of particularity, in during subsequent interventions can be applied to various fields, play a role in maximizing existing design form.

References

- [1] Huifang Zhou: Electronic Devices, Vol. 6 (2004) No 53, p.25-26
- [2] Hongli Zhang: Low-voltage Electrical, Vol. 12 (2005) No 27, p.74-76
- [3] Qin Guo: Shaanxi Technology Institute, Vol. 1 (2006) No 33, p.11-14
- [4] Jieming Liu: Power Electronics Technology, Vol. 3 (2007) No33, p.121-124
- [5] Yanmei Wang: Electrical Technology, Vol. 15 (2010) No27, p.55-57

Fan Yonghong (1982-), female ,she is now a lectur in the Qingdao Huanghai University. Her main research interests are electronic and communications. Tel: +86-15020028872