Comparative analysis of software products for virtual simulation of electrical circuits

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Abstract. This article discusses the use of special software products for the design and simulation of the operation of electrical circuits, namely, the most commonly used programs Electronic Workbench and Multisim are compared, their advantages and disadvantages are determined. In the course of the experiments, on the basis of the above presented software systems, the operation of the electrical circuits of the devices of the amplitude diode detector and the low-frequency amplifier was simulated to identify the capabilities of the programs. In the course of the research, a visual table was compiled, thanks to which it is possible to compare the obtained parameters with the reference characteristics taken from real-life devices. The uptime was chosen as a control parameter, the article contains its calculation formula, and the final calculations are given in the table to better substantiate the capabilities of the software products under consideration. At the end of the article, conclusions are presented on the work done, thanks to which it is possible to determine the pros and cons of each of the programs under consideration.

1 Introduction

Electronic design and development is a very important part of the modern manufacturing process. The development of the device itself is multifaceted and complex and includes many different operations, for example, the design of design documentation, virtual simulation of the device being developed, as well as the creation of a preliminary model of the device.

Reliability studies take a special place in the design of radio electronic devices. Basically, they are of several types, namely, the study of a finished device as a test sample and virtual simulation using specialized programs. For physical research, enterprises build entire laboratories with special equipment for experiments, this method is very expensive and time-consuming, but it also gives the most accurate result. As a result, only large companies can afford such research, and small and medium-sized enterprises are content with only virtual tests, we will consider them in more detail.

Currently, to conduct virtual studies for reliability, you can use many different software systems for modeling, thanks to which you can study a particular process. For example, software environments such as Creo or SolidWorks are mainly used to simulate various

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effects on the design of electronic devices. Our research is connected with modeling the operation of electrical circuits of devices and software tools that allow carrying out such types of analyzes also exist at the present time, these include such programs as Electronic Workbench (EWB), Multisim, OrCad, Proteus, the most common of which are EWB and Multisim [1]. Both of these programs are created by the National Instruments Electronic Workbench Group, the first of which was EWB in 1989. But the Multisim software package was created only in 1999 and is a further development of the EWB system, while having a more sophisticated modeling algorithm in comparison with the previous software development.

2 Research method

One of the most important parameters of device reliability is the uptime, thanks to this parameter, you can evaluate the device's performance and determine its service life. This parameter can be obtained both experimentally using time-to-failure tests, and calculated using a special formula [2]:

$$T_o = \frac{t(n + (n - r))}{0.0072r}$$

where t - is the time spent on measurements; n - is the total number of all measured characteristics; r - the number of characteristics that went beyond the range of normal operation.

The purpose of this study is to determine how the data obtained as a result of modeling in the EWB and Multisim programs differ from the parameters obtained during experiments on physical devices. And whether these characteristics can be used to determine the reliability of the device, in order to simplify the testing for reliability. For these purposes, simple and already well-studied devices were selected, the parameters of which are already known, and the reliability is easily determined using the above formula, to use these parameters as reference characteristics. Such devices are an amplitude diode detector and a low-frequency amplifier, electrical circuit diagrams, which are shown in Figure 1 [3].
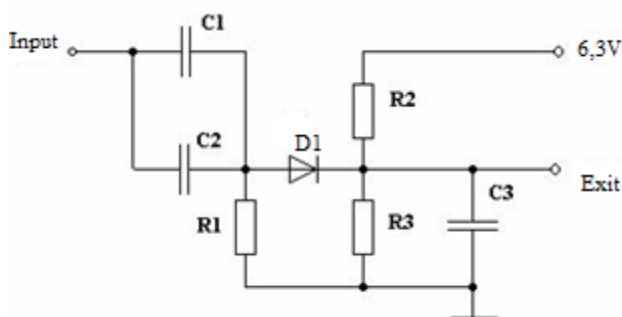

Fig. 1. Electrical schematic diagram of an amplitude diode detector

3 The results of the measurements and calculations

To conduct the experiment, electrical diagrams of these devices were constructed in the EWB and Multisim software environments and the frequency dependence of the output voltage was measured. The obtained parameters are compared with the reference data

obtained during the experiment with physical device layouts. All the obtained parameters are presented in table 1 for better clarity and comparison.

Table 1. The comparison of the received data.

Frequency, Hz	Low frequency amplifier, v			Amplitude diode detector, v		
	Device output	Output EWB	Output Multisim	Output	Output EWB	Output Multisim
1000	0.003966	0.000382977	0.003970	4.2385	4.1012	4.2389
2000	0.003798	0.000184523	0.0038	4.2383	4.2560	4.2386
3000	0.00356	0.000114495	0.003601	4.2376	4.3361	4.238
4000	0.003299	0.000078552	0.003302	4.2376	4.2354	4.2375
5000	0.003045	0.000056987	0.003053	4.2376	4.2362	4.2372
6000	0.002813	0.000042936	0.002826	4.2378	4.24	4.2377
7000	0.002608	0.000033888	0.002611	4.2378	4.2363	4.2381
8000	0.002431	0.000027638	0.002425	4.2379	4.2391	4.2387
9000	0.002278	0.000023065	0.002281	4.2385	4.2377	4.2387
10000	0.002148	0.000019588	0.002139	4.2385	4.2386	4.2390
11000	0.002037	0.000016882	0.002021	4.2392	4.2395	4.2389
12000	0.001941	0.000014773	0.001957	4.2388	4.2405	4.2387
13000	0.001858	0.000013079	0.001841	4.2386	4.2381	4.2385
14000	0.001787	0.000011691	0.001775	4.2381	4.2372	4.2379
15000	0.001724	0.000010545	0.001718	4.2379	4.2368	4.2377
16000	0.00167	0.000009584	0.001662	4.2375	4.2501	4.2374
17000	0.001622	0.000008775	0.001619	4.2375	4.2352	4.2373
18000	0.00158	0.000008081	0.001587	4.2376	4.2383	4.2375
19000	0.001543	0.000007483	0.001538	4.2380	4.2374	4.2381
20000	0.00151	0.000006958	0.001491	4.2385	4.2358	4.2387
21000	0.00148	0.000006506	0.001472	4.2385	4.2172	4.2386
22000	0.001453	0.000006097	0.001449	4.2386	4.2285	4.2387
23000	0.001429	0.000005746	0.001425	4.2389	4.2335	4.2391
24000	0.001407	0.000005425	0.001401	4.2385	4.2406	4.2388
25000	0.001387	0.000005138	0.001395	4.2379	4.2291	4.2380
26000	0.001369	0.000004881	0.001365	4.2374	4.2387	4.2377
27000	0.001353	0.000004641	0.001357	4.2373	4.2356	4.2375
28000	0.001338	0.000004432	0.001341	4.2373	4.2348	4.2374
29000	0.001324	0.000004234	0.001329	4.2377	4.2335	4.2378
30000	0.001311	0.000004056	0.001302	4.2387	4.2255	4.2386

After analyzing Table 1, you can come to some conclusions, so the most accurate data, close to the values that were obtained in the course of studying physical devices, are the characteristics obtained as a result of circuit simulation in the Multisim software package. These parameters begin to diverge from the control characteristics only after 10^{-5} sign; for further mathematical calculations, the resulting error is insignificant. The characteristics obtained thanks to the EWB program are very different from the control measurements of physical devices, some of them at the same measurement frequency do not coincide at all and are different, in this regard, these parameters during further mathematical calculations may show an unreliable solution. The result obtained can be explained by the fact that the Multisim software package is a further development of the EWB, as noted above, and as a result has a more perfect algorithm for modeling processes, in which many shortcomings of the previous version are corrected.

The next step of the study is to find the uptime for the above characteristics according to formula and compare how much the final answer depends on the initial data obtained in

EWB and Multisim in comparison with experimental data, so as a result of calculations, the following expressions were obtained, given in the table 2.

Table 2. Time between failures

	Low frequency amplifier			Amplitude diode detector		
	Model	EWB	Multisim	Model	EWB	Multisim
T	35000	17777.8	35000	1016670	1016670	1016670

After analyzing Table 2, one can make sure that the characteristics obtained as a result of modeling in the Multisim software package are the most similar to the control parameters, since ultimately the uptime calculated from these data does not differ from the uptime calculated from the data obtained in the course of research of physical models of devices. And as noted above, the difference in characteristics obtained as a result of simulating the electrical circuits of devices in the EWB played a bad role, the uptime of the low frequency amplifier differs from the reference value.

4 Conclusion

In this article, a comparative analysis of the EWB and Multisim software products was carried out, with the help of which it is possible to perform a virtual simulation of electrical circuits. In the course of the research, it was revealed that the best system for this type of modeling is the Multisim software product, since the values obtained with this program are the most similar to the values that can be obtained during testing of physical devices, compared to the EWB software package. And as a consequence, the further calculation of the parameters of interest will be carried out most correctly with the smallest error.

References

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