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Analytical report generation module of the EMC simulation software

This paper describes the process of developing the analytical report generation module of the EMC simulation environment and presents the results of creating the prototype. The developed module was implemented and tested in the TALGAT software.

Keywords: graphical user interface, electromagnetic compatibility, Qt, TALGAT.

Ensuring electromagnetic compatibility (EMC) is an important task in the development of radioelectronic equipment. This task is usually associated with expensive and time-consuming tests. Therefore, it is advisable to take EMC into account at the design stage by simulating it with specialized software. Modern trends in software development in this area encourage developers to introduce various analytical tools and elements of expert systems (ES) into a software product.

The use of modern computer technologies makes it possible to develop ESs that contain a database (DB) of large data volumes with the possibility of their expansion and backup. In addition, when solving EMC problems, ESs rely only on embedded mathematical models, algorithms, and knowledge bases, which give more objective results, and therefore the possibility of errors is extremely small.

Domestic software TALGAT is one of the products that can solve a wide range of EMC-related problems; however, analytical support and reference data are very limited [1]. A detailed analysis of the system revealed that when users utilize the DB module of signals affecting power supply network, they may encounter difficulties due to the need to re-run the simulation process, as well as the need to manually group and analyze the simulation results [2].

The aim of this work is to design and develop the analytical report generation module of the EMC simulation software and implement it in the TALGAT system.

Module development

In the development process, the programming languages C++ and Python were used, as well as the Qt framework since the TALGAT system is based on the use of these tools and includes the Python interpreter. The C++ language was used to create the internal structure of the module in the core of the TALGAT system. The graphical user interface was created using the **Qt Widgets technology** of the Qt framework. A distinctive feature of this module is the fact that when the module is running, it generates a code in Python, which is then executed by the system itself. This allows more experienced users of the TALGAT system to make their own changes to the design of the resulting code.

The main purpose of the developed module is to identify potential vulnerabilities of the power supply network when it is exposed to dangerous interference signals. The identification process is based on calculating the normalization response parameters [3]. To ana-

lyze the user-defined topology, the module uses the norms N_1-N_5 and 10 signals of the DB subsystem. Switching to the module operation mode is available by clicking the «Generate report» flag in the time analysis settings menu. Figure 1 shows the block diagram of the module operation algorithm.

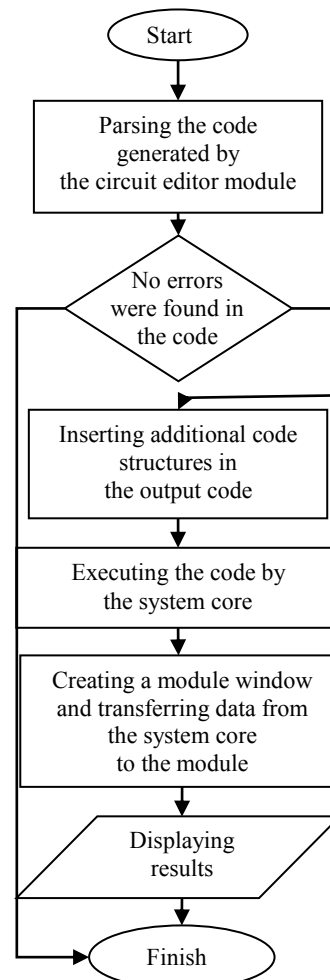


Fig. 1. Block diagram of the analytical report generation module operation

The stages of the module operation are detailed below. At the first stage, the developed functions in the TALGAT system core generate circuit code in Python. In fact, a function written in C++ creates the code written in another language. After that, the module parses the code to find the entry points for new parts of the

code. Then, it checks whether the entry points and keywords are found. If they are not found, the module stops working and displays an information window with an error message. If the module does not find any errors, the module functions start processing the code structure. The resulting code is displayed as a text in the system editor interface window. This is necessary in order to ensure transparency of the module and allow users to make changes or improve the code. The resulting code is a combination of functions, conditions, loops and vector operations. The system executing the created code automatically calculates the responses of the user topology to the effect of 10 interference signals implemented in the DB. After that, the data is passed to the module. The module calculates 5 norm values for each of the signals in each topology segment. Then, the segments of the structure where the norm values are maximal are determined. After that, the maximum value of the voltage in the response for this segment is determined, which is normalized relative to the maximum value of the input signal voltage.

As a result, the system creates a graphical window of the module containing analytical information (Fig. 2).

Signals	Norm 1	Norm 2	Norm 3	Norm 4	Norm 5	max input voltage
2 FID_FPG30-1KM	1.087V seg...	1.087V seg...	0.939V seg...	0.939V seg...	0.939V seg...	11069.9
3 GaAs_Source	1.000V seg...	1.000V seg...	1.000V seg...	1.000V seg...	1.000V seg...	35262.4
4 HVPS_pulser	1.238V seg...	0.988V seg...	1.243V seg...	1.243V seg...	1.238V seg...	2018.42
5 HVPS_SOURCE	2.426V seg...	0.70V seg...	0.40V seg...	1.243V seg...	0.85V seg...	85.6429
6 Krzikalla_et_al	1.449V seg...	1.205V seg...	1.153V seg...	1.153V seg...	1.331V seg...	241.532
7 Nyffeler_et_al	1.218V seg...	1.035V seg...	0.993V seg...	0.993V seg...	1.206V seg...	498.553
8 P.S_PGS-402	0.463V seg...	0.355V seg...	0.450V seg...	0.380V seg...	0.380V seg...	423.403
9 Parfenov_et_al	1.000V seg...	1.000V seg...	1.000V seg...	1.000V seg...	1.000V seg...	112.611
11 STUN GUN	0.981V seg...	0.836V seg...	0.755V seg...	0.717V seg...	0.717V seg...	351.527

Fig. 2. Main window of the analytical report generation module

The results are displayed in the central table of the module window. The table contains information about the number of the transmission line and the number of the segment containing the maximum value of the N-norm. Depending on the normalized maximum voltage value, the background color of the corresponding table cells changes (from green to dark red), indicating the most vulnerable parts of the topology. The table on the right shows the maximum voltage of the input signal and the names of the signals from the DB. When the user clicks on the table cells in the lower part of the window, the module displays portraits of N-norms normalized relative to the N_1-N_5 values of the input interference signal. This allows the user to examine in detail the vulnerable nodes of the user-defined topology. Fig. 3 shows a graphical representation of the norm N_1 relative values. It is also worth noting that if you expand the signal database, the number of signals used in the module also increases.

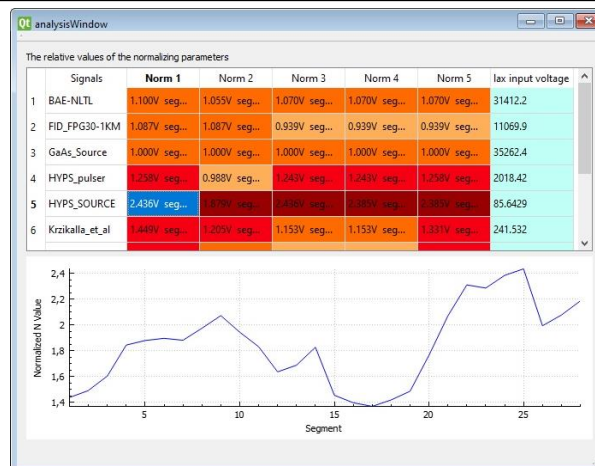


Fig. 3. Example of using the graphical display of relative norm values

Conclusion

Thus, the developed module can be used to collect, transform and provide information received from the TALGAT system in an analytical form. In the future, it is planned to improve the module by implementing a knowledge base (in the form of rules), which will provide the user with additional information about changes that can be made to the analyzed structure. However, even in its current form, this tool can be used for research purposes.

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