ISSN 0735-2727, Radioelectronics and Communications Systems, 2014, Vol. 57, No. 5, pp. 224–228. © Allerton Press, Inc., 2014.
Original Russian Text © Yu.A. Onikienko, 2014, published in Izv. Vyssh. Uchebn. Zaved., Radioelektron., 2014, Vol. 57, No. 5, pp. 44–51.

Simulation of Conducted Interferences of Class D Amplifier

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Received in final form September 16, 2013

Abstract—It is proposed an approximate approach to simulation of conducted interferences of amplifier of class D on a basis of equivalent circuit with elements, defining generation and propagation of conducted interferences. For calculation we use amplitude, output voltage pulse repetition cycle and duration, and also pulse rise time. Calculation results in the whole correspond to experimental data.

DOI: 10.3103/S0735272714050057

INTRODUCTION

Amplifiers of class D, like another pulse voltage converters are characterized by high energy efficiency, but their essential drawback is enough level of generated electromagnetic interferences (EMI).

International and national standards require rigid level of electromagnetic emission of pulse converters [1], that is why it is necessary to solve the problem of electromagnetic compatibility (EMC) at the stage of development [2] and improvement, but with additional cost. In this connection simulation of EMI levels of developed devices is necessary tool, allowing to reduce essentially time consumption and cost.

Now for analysis and simulation of conducted EMI levels the methods of equivalent circuits are used. In papers, devoted to simulation of conducted interferences [3–9] configuration of equivalent circuit and its parameters and necessity of computational cost for calculation of EMI levels are defined by following factors:

1. Interference voltage division by symmetric and asymmetric components or analysis of interferences voltages in form of signal at the output the artificial mains network. Interferences division allows to simplify analysis of their propagation path and development of interference-suppression filters, but it requires special facilities for measurement for selection symmetric and asymmetric components from aggregate interference voltage [3].

2. Transient or frequency analysis. Advantage of transient analysis [4] is its resolution and accuracy. The drawbacks are great calculation time and possible convergence problems. Methods of frequency analysis [5] allow to simplify simulation and decrease essentially calculation time, but they are frequency restricted. There are combined methods [6], including both transient and frequency analysis.

3. Representation of objects modeled as a "black box". In this case separate transformer elements (output switches, which are interference sources, passive elements, transmitting the interference, etc.), and sometimes the transformer as a whole are considered as a "black box" and required parameters are obtained with measurements [7–9].

Amount of measurements depends on "black box" complication. Advantage of such approach is high model accuracy, defined by equipment precision only. The drawback is necessity of several measurements in case of modification of the device operation mode. Decrease of amount of equivalent circuit elements with unique characteristics and requiring measurements for their parameters obtain results in more universal model form, but it decreases its accuracy.

The purpose of the paper is development of the approximate approach to simulation of conducted EMI calculation for class D amplifier, requiring minimal computational cost and providing the results accuracy, which is enough for preliminary estimation of the interferences level.

The proposed approach to EMI simulation includes the following steps:

— development of advanced equivalent circuit taking into account parasitic parameters of the amplifier and the circuit equivalent;

— creation of mathematical model for calculation of the conducted interferences levels;

— obtaining of design data with minimal computational cost (for example, Mathcad software);