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ANALYSIS OF THE INFLUENCE OF TEMPERATURE ON THE MODAL FILTER ATTENUATION COEFFICIENT IN DIFFERENTIAL AND COMMON MODES

V.P. Kosteletskii, postgraduate student,
Department of Television and Control
Scientific adviser A.M. Zabolotsky, DScTech, professor
Tomsk, Tomsk State University of Control Systems and Radioelectronics,
kosteletskiy.vp@gmail.com

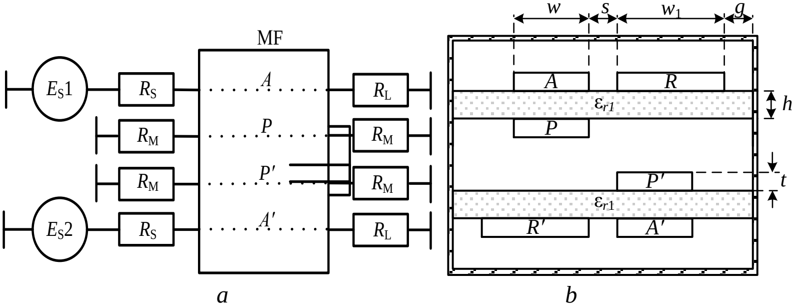
This article considers the effect of temperature on the modal filter attenuation coefficient in the temperature range from –50°C to +150°C. In the differential mode the attenuation coefficient decreases by at least 2.5%, while in the common mode it increases by maximum 1.3%. We present the results of calculating the time responses in differential and common modes, obtained using the quasi-static approach.

Keywords: temperature, protection device, modal filter, electromagnetic compatibility, differential mode, common mode, ultrashort pulse.

Today, there is a widespread use of radio electronic equipment (REE) in all areas of human activity, which imposes special requirements for electromagnetic compatibility (EMC) [1]. Among all the possible interfering influence, the ultra-short pulse (USP) is worth mentioning [2]. The spectrum of USP covers a wide range of frequencies. As a result of which it can overcome traditional protection from interference [3]. There are devices for suppressing a USP, based on the principle of modal decomposition [4].

Such devices include microstrip modal filters (MF), and meander delay lines [5]. They are devoid of the drawbacks inherent in traditional means of protection. However, such devices are not capable of suppressing interference in differential and common mode propagation simultaneously. It should also be noted that the effect of temperature on the attenuation coefficient has not previously been evaluated. The purpose of this work is to investigate the effect of temperature on the MF attenuation coefficient in differential and common modes.

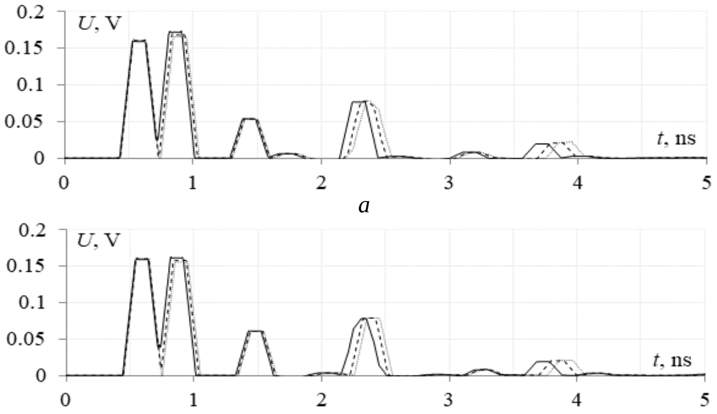
The investigation of the dependence of MF parameters on temperature is performed using a mathematical temperature model as in [6]. To verify the operability in the temperature range from –50 to +150 °C, a simulation of the MF was performed. To protect the REE in differential and common modes, it is proposed to use a modal filter. Fig. 1 shows the connection scheme, the cross-section and parameters of the MF. In the diagram below, E_{S1}, E_{S2} are electromotive force (EMF) sources, R_S is the value of the generator resistance, R_L is the load resistance, R_M is the value of matching resistors, A, A' are active conductors and P, P' are passive conductors. The cross sections have the following designations: w is the width of active and passive conductors, w_1 is the width of the reference conductor, s is the distance between conductors, t is the thickness of conductors, h is the thickness of the dielectric substrate, g is the distance between the reference conductor and shield, ε_r is the relative dielectric permittivity of substrate and structure length l = 110 mm.



a *b*

Fig. 1. Connection diagram (*a*) and cross-section of the MF (*b*)
Conductors: *A* is active; *P* is passive; *R* is the reference

Calculation of time responses and MF parameters was implemented in the TALGAT software [7]. A single pulse with the duration of the front, fall and flat top of 100 ps each was used as a test excitation. To simulate the differential mode, the MF was subjected to excitation pulses with an EMF amplitude of 0.5 V for E_{S1} and –0.5 V for E_{S2}. For the common mode, $E_{S1} = E_{S2}$ = 1 V. The resistance values of the generator RS, load RL and resistors RM are equal to each other. Fig. 2 shows the voltage waveforms at the MF output under differential and common modes excitations.



a

b

Fig. 2. Voltage waveforms at the output of the MF in differential (*a*) and common (*b*) modes, at temperature: T = –50 (**……**), +50 (– – -) and +150 (–––) °C

In the differential and common modes, the maximum amplitude of pulses at the MF output was 171 and 161 mV, respectively. The minimum attenuation coefficient (Fig. 3) in the common mode and differential modes is the ratio of the input voltage to the maximum pulse amplitude at the MF output.

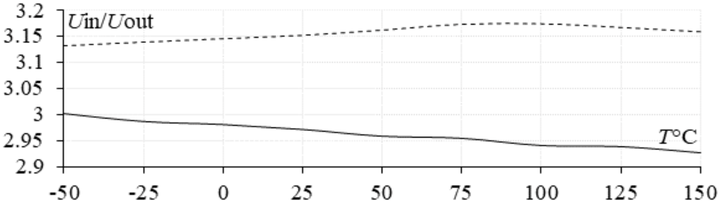


Fig. 3. Dependence of the minimum MF attenuation coefficient with temperature in differential (——) and common (– – – -) mode

When changing the temperature in the range from –50 to +150°C, the minimum attenuation coefficient of the MF in the differential mode smoothly decreases by 2.5%. In the common mode, in the temperature range from –50 to +100 °C, the attenuation coefficient smoothly increases by 1.3%, and further decreases to 0.83%.

Thus, changing the temperature of the MF in the range from –50 to +150 °C does not change its attenuation coefficient significantly. This allows the MF to operate in harsh environments without significant changes in its protective capabilities.

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MESH GENERATION ALGORITHM FOR CALCULATING THE ELECTROSTATIC FIELD BY THE METHOD OF MOMENTS

A.A. Kvasnikov, postgraduate student,
Department of Television and Control;
K.E. Zinoviev, undergraduate student,
Department of Automated Control Systems
Scientific adviser S.P. Kuksenko, Doctor of Engineering Sciences,
Associate Professor, Department of Television and Control
Tomsk, TUSUR, aleksejkvasnikov@gmail.com

This paper describes the process of developing the mesh generation algorithm for calculating the electrostatic field of a transmission line by the method of moments. The developed algorithm is implemented and tested in the TALGAT software.

Keywords: electrostatic field, transmission line, method of moments, mesh generation, electromagnetic compatibility, TALGAT software.

Ensuring electromagnetic compatibility (EMC) is an important task in the development of radioelectronic equipment (RE). Therefore, it is recommended to use mathematical modeling, which can reduce the financial costs and time spent on the RE development, in comparison with physical modeling. At the same time, one of the universal numerical methods used in the simulation of EMC problems is the method of moments (MoM).

One of the important tasks in the simulation of EMC problems is to estimate the distribution of the electrostatic field excited by the RE components, such as transmission lines. At the same time, the complexity of the physical connections of the simulated structures is often very high, so designers have to use specialized software that allows them to calculate and visualize the field distribution in the studied structures.