ТУСУР | TUSUR UNIVERSITY

Сборник избранных статей научной сессии ТУСУР

ПО МАТЕРИАЛАМ МЕЖДУНАРОДНОЙ НАУЧНО-ТЕХНИЧЕСКОЙ КОНФЕРЕНЦИИ СТУДЕНТОВ, АСПИРАНТОВ И МОЛОДЫХ УЧЕНЫХ

«НАУЧНАЯ СЕССИЯ ТУСУР–2020»

г. Томск, 13–30 мая 2020 г.

(в двух частях)

ЧАСТЬ 2

г. Томск

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**по материалам
Международной научно-технической конференции
студентов, аспирантов и молодых ученых
«Научная сессия ТУСУР–2020»**

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Сборник избранных статей научной сессии ТУСУР включает избранные доклады по итогам Международной научно-технической конференции студентов, аспирантов и молодых ученых. Конференция посвящена различным аспектам разработки, исследования и практического применения радиотехнических, телевизионных и телекоммуникационных систем и устройств, сетей электро- и радиосвязи, вопросам проектирования и технологии радиоэлектронных средств, аудиовизуальной техники, бытовой радиоэлектронной аппаратуры, а также автоматизированых систем управления и проектирования. Рассматриваются проблемы электроники СВЧ- и акустооптоэлектроники, нанофотоники, физической, плазменной, квантовой, промышленной электроники, радиотехники, информационно-измерительных приборов и устройств, распределенных информационных технологий, вычислительного интеллекта, автоматизации технологических процессов, в частности, в системах управления и проектирования, информационной безопасности и защиты информации. Представлены статьи по математическому моделированию в технике, экономике и менеджменте, антикризисному управлению, правовым проблемам современной России, автоматизации управления в технике и образовании, а также работы, касающиеся социокультурных проблем современности, экологии, мониторинга окружающей среды и безопасности жизнедеятельности.

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СЕКЦИЯ 8
POSTGRADUATE AND MASTER STUDENTS' RESEARCH IN ELECTRONICS AND CONTROL SYSTEMS

(Секция на английском языке)

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curs in the mirror of the active wire where the values of the maximum currents become smaller; here we can also notice the same situation with the active wire but we found that another peak shows up at a distance of 48 mm, which means that the distance between the wire and its mirror is one sixth of the wavelength.

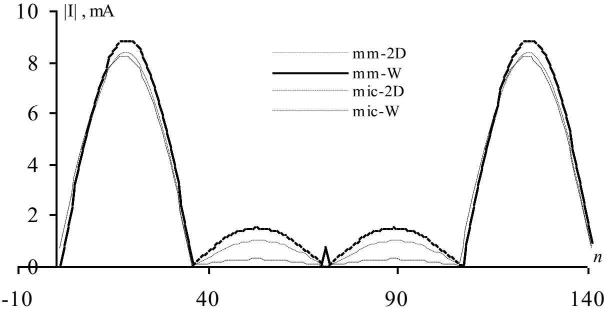

Fig. 2 The current distributions along the wires

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A MODAL FILTER WITH A PARALLEL OSCILLATORY CIRCUIT IN A PASSIVE CONDUCTOR

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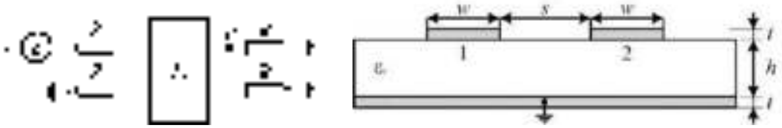
The paper presents the analysis of the frequency response of a two-wire modal filter (MF) with a parallel oscillating circuit in a passive conductor and shows that resonators allow increasing insertion losses in the attenuation band. The results were obtained for the electrodynamic simula-

tion of an MF with and without resonators in time and frequency domains without losses.
Keywords: modal filter, resonator, parallel oscillating circuit, electromagnetic interference, noise suppression, electrodynamic simulation.

High-potential ultra-short pulse (USP) protection devices are devices based on the principle of modal decomposition. Such devices include phase splitters, meander lines and modal filters (MF) [1]. A pulse of a shorter duration passing through such a device undergoes modal decomposition. Due to the fact that the pulse modes propagate at different phase velocities, under decomposition conditions, a series of pulses of smaller amplitude is observed at the output of the MF. Their number is equal to the number of basic modes in the transmission line. Fig. 1 presents a schematic diagram and a cross-section of the two-wire MF.



a *b*

Fig. 1. The schematic diagram (*a*) and the cross-section (*b*) of the two-wire MF

There are several approaches to changing time and frequency characteristics of MFs. The most common is adding passive conductors and using them as resonators [2, 3]. The disadvantage of this approach is a significant increase in the geometric dimensions of MFs. The main purpose of this study is to analyze the change of the frequency response of a two-wire MF by using a parallel oscillating circuit in the break of passive conductor (Fig. 2).

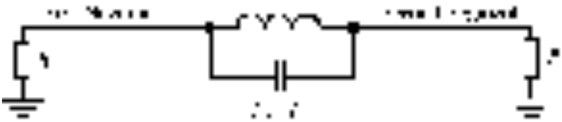


Fig. 2. The parallel oscillating circuit in the conductor break

To provide matching of the MF wave impedance with 50 Ohms and meet the USP decomposition conditions, we chose the following MF parameters: the conductor width $w = 0.79$ mm, the distance between conductors $s = 0.1$ mm, the thickness of conductors $t = 35$ μm, the thickness of dielectric $h = 0.5$ mm, the relative dielectric constant $\varepsilon_r = 4.3$ (presented for 1 MHz), the length $l_0 = 0.5$ m. The passive conductor is divided into segments whose lengths are selected for the required resonance frequencies ($f_{\text{rez1}} - f_{\text{rez4}}$). The separation is performed by using parallel oscillating *LC* circuits tuned to these frequencies. Thus, the passive conductor is divided into 4 segments (Fig. 3), with $l_1 = 0.125$ mm, $l_2 = 0.125$ mm, $l_3 = 0.07$ mm, $l_4 = 0.180$ mm. This provides the following resonance frequency ratios: $f_{rez2} = f_{rez1} \times l_0 / (l_1 + l_2 + l_3)$, $f_{rez3} = f_{rez1} \times l_0 / (l_1 + l_2)$, $f_{rez4} = f_{rez1} \times l_0 / l_1$.

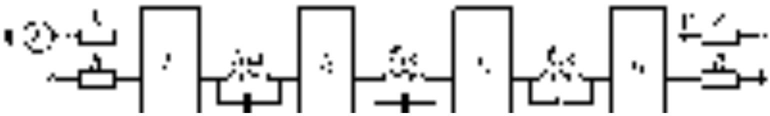


Fig. 3. The schematic diagram of the two-wire MF with resonators

To obtain frequency and time characteristics, we applied the electrodynamic approach based on the finite integration method; simulation was performed without losses.

Figure 4 and 5 represent the results of the simulation in the frequency and time domains, respectively. It should be noted that the separation of the passive conductor into segments has weak effects on the cut-off frequency (f_c) of the MF. Thus, for the structure with and without resonators, f_c was 0.797 and 0.791 GHz, respectively. The first resonance frequency of f_{rez1} for the investigated structure was 1.59 GHz. Based on the above mentioned resonance frequency ratios, we obtained the following values: $f_{rez2} = 2.5$ GHz, $f_{rez3} = 3.2$ GHz, $f_{rez4} = 6.4$ GHz. The presence of additional resonances allows increasing the insertion losses at the required frequencies.

Fig. 4. The simulation results in the frequency domain

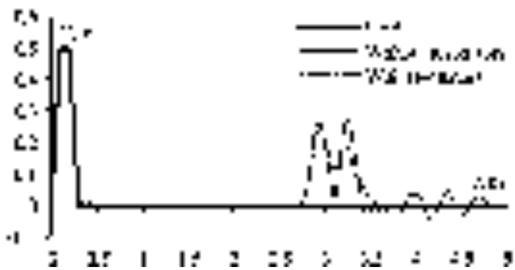


Fig. 5. The simulation results in the time domain

The results of time and frequency domain simulations of the MF without resonators show that a USP decomposes into two pulses of equal amplitudes. The amplitudes of the first and second pulses decrease due to the presence of resonators; reflections are observed.

Thus, the paper presented the results of the analysis of how the response frequency of a two-wire MF can be changed by using a parallel oscillating circuit in the passive conductor. The resonators created with this method increase the insertion losses. Separation of the MF's passive conductor into segments has weak effect on the cut-off frequency. However, it allows for better attenuation at given frequencies.

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DATA IMPORT AND EXPORT MODULE OF THE EMC SIMULATION SOFTWARE

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This paper describes the process of developing the data import and export module of the EMC simulation environment and presents the results of creating the submodules. The developed module is implemented and tested in the TALGAT software.

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

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 into account EMC at the design stage by simulating it with specialized