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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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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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MODAL DECOMPOSITION OF AN ULTRASHORT PULSE IN THE REFLECTION SYMMETRIC MEANDER LINE WITH CONDUCTORS CONNECTED AT ONE END

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The article considers the possibility of ultrashort pulse decomposition in a reflection symmetric meander line in which all 4 conductors are connected at one end. The results of the time response simulation at the output of the line are presented, which are useful for improving ultrashort pulse protection devices.
Keywords: electromagnetic compatibility, protection device, ultrashort pulse, modal filtering, reflection symmetric meander line.

Ensuring electromagnetic compatibility (EMC) of radio-electronic equipment (REE) for various purposes is increasingly relevant. This is primarily due to a significant expansion of different REE and the growing complexity of its implementation. One of the most important tasks of EMC is to increase noise immunity during the process of developing such systems [1]. It is known that powerful electromagnetic interferences of short duration, also called ultrashort pulses (USP), can disrupt the performance of the equipment or even disable it [2, 3]. In vital areas (military, nuclear, space, medical area, etc.) this is completely unacceptable. To protect REE against USPs, a modal filtration technology has been proposed. This technology is based on the modal decomposition of an interfering pulse into a sequence of pulses of lower amplitude [4]. Devices operating in accordance with this technology are called modal filters (MF) and protective meander lines (ML). They have a number of advantages compared to traditional protection devices (radiation resistance, long service life, low cost, etc.).

Various configurations of such structures were investigated, including structures with reflection symmetry [5]. Meanwhile, the possibility of decomposing a USP in a reflection symmetric ML (Fig. 1) in which all 4 conductors are connected at one end has not been previously considered, although this is relevant. The purpose of this work is to carry out such a research.

At the initial stage of the research of such configuration of a reflection symmetric ML with a length of 1 m, it is advisable to perform quasistatic simulation without taking into account the losses. To simulate the time response, we used a source of pulse signals represented by an ideal EMF source with amplitude – 5 V and with durations of rise, fall and flat top of 50 ps each, so that t_Σ = 150 ps (Fig. 2, *a*). The connection diagram of a half-turn is shown in Fig. 2, *b*. The MF was simulated with the optimized cross-section parameters from [5], which ensured that the time intervals between the per-unit-length delays of modes were equal and the output signal voltage amplitudes were paired.

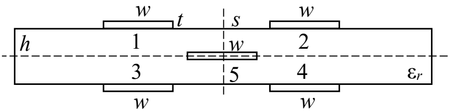
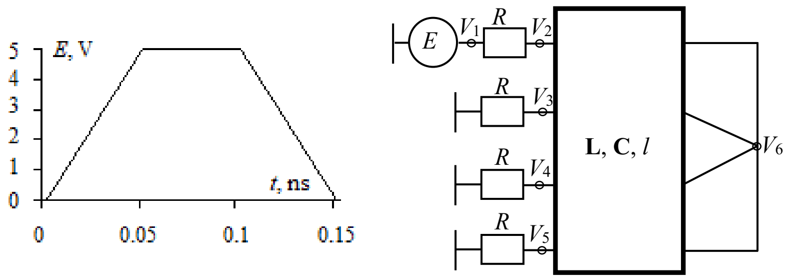


Fig. 1. Cross section of the reflection symmetric structure



a *b*

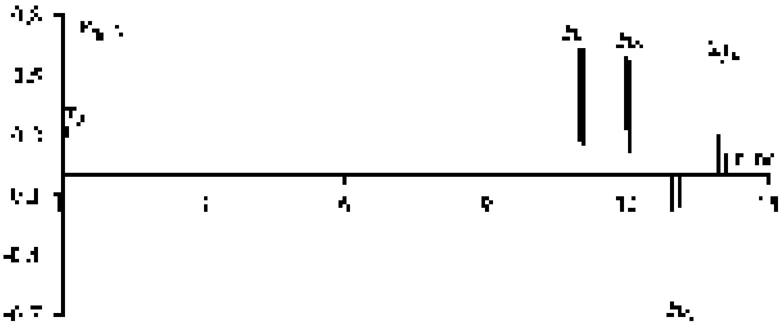
Fig. 2. EMF waveform (*a*) and schematic diagram (*b*) of reflection symmetric ML under study

The simulation results (values of the maximum pulse voltage at the end of the active conductor U_i and time intervals between the decomposition pulses Δt_i) of the reflection symmetric ML are summarized in the table. The voltage waveforms at the ML outputs (V_3, V_4 and V_5) are shown in Fig. 3.

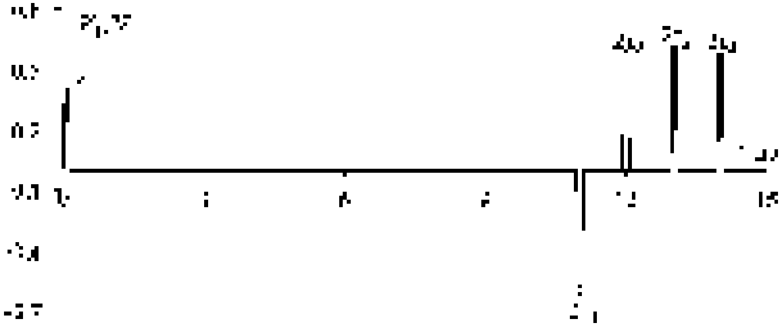
Characteristics of the reflection symmetric ML

Node	U_0, V	U_1, V	U_2, V	U_3, V	U_4, V	Δt_1, ns	Δt_2, ns	Δt_3, ns
V_3	0.23956	0.63018	0.595582	–0.61775	0.57269	0.9777	1.0301	0.981
V_4	0.40658	–0.63020	0.595601	0.617778	0.57209	0.9777	1.0301	0.981
V_5	0.11395	0.63016	–0.59556	0.617744	0.57267	0.9777	1.0301	0.981

Fig. 3 shows that the structure under study is capable of decomposing the USP into 5 pulses of lower amplitude: the first pulse with a delay of τ_0 is crosstalk at the near end of the line, and the second and fifth pulses with delays of $2\tau_1 – 2\tau_4$ are a sequence of four main pulses, one of which has a negative polarity. The maximum value of the output voltage is determined by the amplitude of the first pulse (0.63 V), which is 8 times less than the EMF and slightly higher than the maximum output voltage obtained by simulating the reflection symmetric MF (0.625 V) [5]. In addition, in contrast to the reflection symmetric MF, the time intervals between the decomposition pulses are doubled. This allows decomposing a USP which is twice as long, with the complete absence of resistors at all ends of the line.



a



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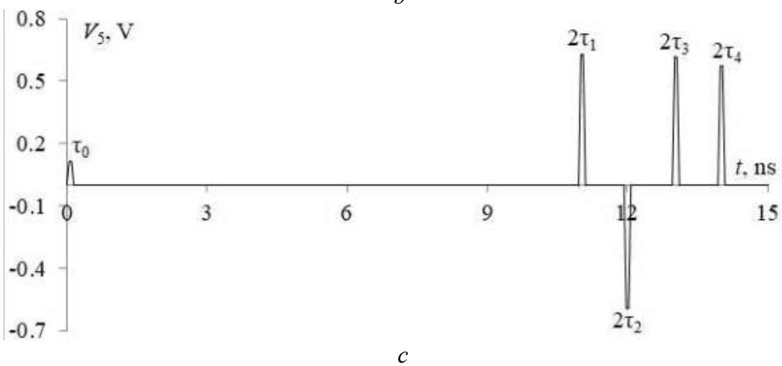

c

Fig. 3. Waveforms of output voltages of the reflection symmetric ML under study

Thus, in the structure of a reflection symmetric ML, in which all the conductors are connected at one end, it is possible to decompose the excitation USP into a sequence of pulses with a maximum amplitude less than the EMF amplitude. In addition, such a connection will dispense with the resistors at the far end of the line, which increases reliability and reduces costs.

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REFERENCES

1. Radasky W.A., Baum C.E., Wik M.W. Introduction to the special issue on High-Power Electromagnetics (HPEM) and Intentional Electromagnetic Interference (IEMI) // Special issue of IEEE Transactions on Electromagnetic Compatibility. – 2004. – Vol. 46, No. 3. – P. 314–321.

2. Yurkov N.K., Zatylkin A.V., Polesskij S.N., Ivanov I.A., Lysenko A.V. Information technology for multi-factor reliability of complex electronic systems. (Informacionnaya tekhnologiya mnogofaktornogo obespecheniya nadezhnosti slozhnyh elektronnyh system) // Nadezhnost' i kachestvo slozhnyh sistem. – 2013. – No. 4. – P. 75–79. (In Russian).

3. Mora N., Vega F., Lugrin G., Rachidi F., Rubinstein M. Study and classification of potential IEMI sources // System and assessment notes. – Note 41. – 8 July 2014.

4. Gazizov A.T., Zabolotsky A.M., Gazizov T.R. UWB pulse decomposition in simple printed structures // IEEE Transactions on Electromagnetic Compatibility. – 2016. – Vol. 58, No. 4. – P. 1136–1142.

5. Chernikova E.B., Belousov A.O., Gazizov T.R., Zabolotsky A.M. Using reflection symmetry to improve the protection of radio-electronic equipment from ultrashort pulses // Symmetry. – 2019. – Vol. 11(7), No. 883. – P. 1–25.

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THE EFFECT OF THE DIMENSION DOMAINS ON THE CURRENT DISTRIBUTION ALONG TWO COUPLED WIRES OVER A GROUND PLANE

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An algorithm for estimating the radiated emission from modal-reservation circuits was proposed, which shows an acceptable match in the current distribution and the radiation pattern of the two-wire test structure. This paper is aimed at testing this algorithm in two different dimensions. The results proved the possibility of using this algorithm in different dimensional domains, as long as they satisfy the limits of quasi-static analysis.

Keywords: modal-reservation, radiation pattern, quasi-static.