

# Investigation of memristors' own parasitic parameters and mutual inductances between neighbouring elements of memristor matrix and their influence on the characteristics

## Extended abstract

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**Abstract** — The main purpose of this paper is to investigate the influence of the mutual inductance between the memristors of a memory matrix and of the memristor parasitic parameters on their characteristics at impulse mode. The values of the parasitic capacitance and inductance of a memristor are calculated. In the experiments three possible values of the coefficient of magnetic connection between elements are used. The equivalent memristor circuit is analysed in MATLAB environment. The basic effects from the analysis are given. The main result is that the parasitic parameters do not strongly affect the memristor voltage drops at frequencies up to 2 GHz.

**Keywords**—titanium-dioxide memristor; parasitic parameters; mutual inductance; memristor characteristics

## I. INTRODUCTION

One of the most interesting and useful property of the memristor is to memorize the full amount of charge which has passed through it [1, 2, 3]. Many research investigations and simulations on this nonlinear circuit element have been made in last few years [4, 5, 7]. The main properties and the principle of operation of Williams's memristor have been presented. Some physical dependencies between the basic electrical quantities of the memristor have been shown in the literature [1, 8, 9]. Like every electrical element the titanium-dioxide memristor has parasitic capacitance and inductance. Made on an integrated circuit every two

neighboring memristors have also mutual inductance. These parameters are dependent on the memristor chip size and the position of the memristors investigated. In the papers published so far no data on this topic have been found. The main purpose of this paper is to propose adequate substituting circuit and a suitable model for further analysis.

In Section II an equivalent substituting circuit of two neighboring memristors is proposed. The concrete values of the parasitic parameters and of the mutual inductance are calculated in Section III. The SIMULINK model based on the circuit presented and the results of the simulation realized are given in Section IV. The concluding remarks are presented in Section V.

## II. EQUIVALENT SUBSTITUTING CIRCUIT OF TWO NEIGHBOURING MEMRISTORS OF A MEMRISTOR MEMORY MATRIX

The equivalent scheme of the two nearly placed on a matrix memristors is presented in Fig. 1. The capacitors  $C_1$  and  $C_2$  present memristor's own capacitances due to the overlapping between the memristor electrodes. The inductors  $L_1$  and  $L_2$  present the parasitic inductances of each of platinum rims. The coefficient  $M$  is almost equal to each of inductances because of full embracement of the magnetic flux by both of the platinum rims of the elements.

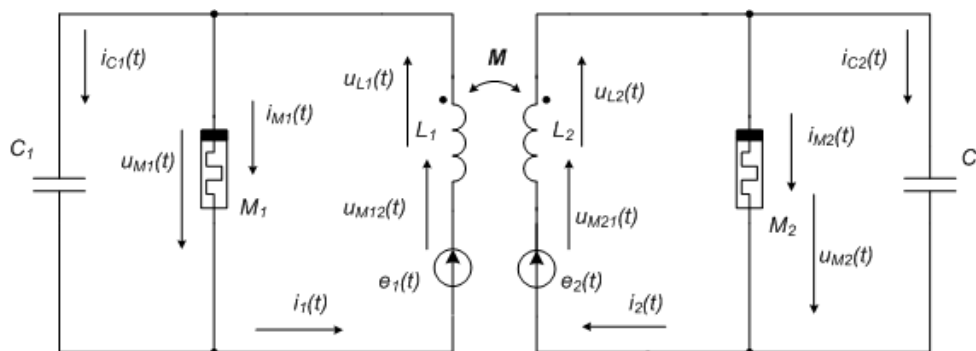


Fig. 1. Equivalent circuit of two neighboring memristors of memory matrix

### III. CALCULATION THE PARASITIC CAPACITANCES AND INDUCTANCES AND OF THE MUTUAL INDUCTANCE

The capacitances  $C_1$  and  $C_2$  are calculated as a capacitance of a plane capacitor. The obtained value of the parasitic capacitance is  $C_{par} = 3.10^{-16} F$ .

The parasitic inductance is calculated with solving of double definite integral and with using of magnetic field theory. The parasitic inductance of a memristor placed in the center of the memory matrix has the value of  $L = 9 nH$ .

The mutual inductance  $M$  is calculated with participation of the mutual magnetic flux of the parallel wires. Their

value is near to the value of the memristor's own inductances.

### IV. SYNTHESIS OF A SIMULINK MODEL OF THE CIRCUIT INVESTIGATED AND PRESENTATION OF THE SIMULATION RESULTS AT IMPULSE MODE

The SIMULINK model of the circuit investigated is presented in Fig. 2. This circuit will be also used for analysis of the equivalent circuit when the elements have manufacture tolerances of their basic parameters [6].

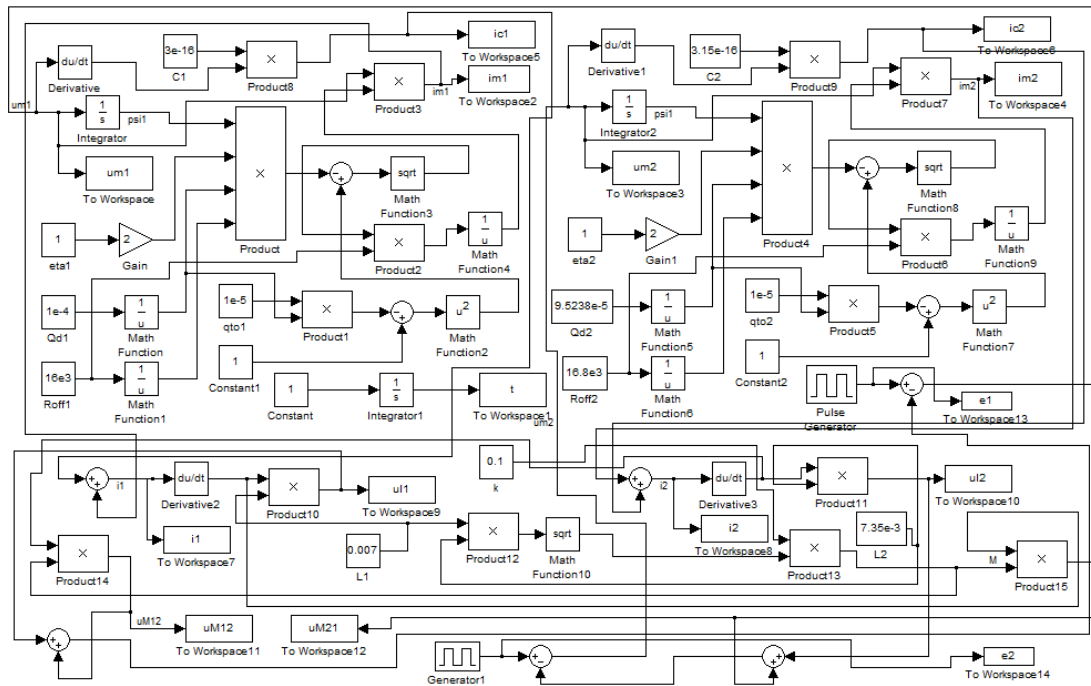


Fig. 2. SIMULINK model of the memristor circuit investigated

### V. CONCLUSIONS

From the results presented above it is clear that with increasing the frequency of the impulse sequence the parasitic parameters have stronger influence on the impulse distortions. But at signals with frequencies up to 2 GHz these parameters do not have significant effect on the impulse signals. The tolerances of the memristor parameters have stronger influence on the memory matrix characteristics.

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