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Stability analysis of multimode oscillations in three coupled memristor-based circuits

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Abstract

In this paper, first we construct a simple flux-controlled memristor-based circuit. By means of the ladder-type circuits coupled with inductors, furthermore, the three mutually coupled memristor oscillator circuits are designed. We mainly discuss dynamical behavior of three coupled memristor-based circuits, i.e., investigate the stability of the zero, single, double and multimode oscillations. Based on Krylov-Bogoliubov linearization method, the stability of the multimode oscillation for such circuits is determined in detail. Finally, computer simulations are conducted to verify the correctness of theoretical results.

Keywords: Flux-controlled memristor; oscillator circuits; multimode oscillations, stability

1. Introduction

The memristor is one of the four fundamental electronic elements in the circuit. At the beginning of 1970s [4], Leon Chua attempted to establish the six different mathematical relationships, which connecting pairs of the four fundamental circuit variables, i.e., the current i , the voltage v , the charge q and the flux φ . However, he observed that five of these relationships were well-known. Two of them are given by the definition of electric current and Faraday's law, i.e., $i = \frac{dq}{dt}$, $v = \frac{d\varphi}{dt}$. And, the others are given by the basic equations, which have axiomatically defined the three classical circuit elements, namely, $R = \frac{dv}{di}$, $L = \frac{d\varphi}{di}$, $C = \frac{dq}{dv}$, the R , L and C represent the resistance, the inductance, and the capacitance, respectively. Furthermore, Chua found that one relationship was undefined, i.e., the relationship between the flux φ and the charge q . Based on his observation, in 1971, he postulated in the seminal paper [15] that the fourth basic two-

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