The Complete Bifurcation Analysis of Buck Converter Under Current Mode Control

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Abstract. The paper is devoted to the complete bifurcation analysis of the nonlinear dynamics of one of the most widely used switching power supplies – buck converter under current mode control. The applied Method of Complete Bifurcation Groups allows the detection of all stable and unstable periodic modes of operation, showing the complicated structure of bifurcation patterns and their interaction with chaotic attractors. The research aims to identify the regions in the parameter space where the converter could operate as a source of robust chaotic oscillations.

Introduction

Chaotic dynamics of electronic circuits have raised great interest for several decades. The applications range from embedded chaos-based cryptosystems [1], intelligent sensing [2], and secure data transmission [3] to chaotic computing [4] and quantum chaos [5]. One of the most topical problems is the generation of chaotic oscillations. Different circuits have been proposed based on classical Chua or Rossler oscillators[6], digital implementation of chaotic maps [7], or production defects of commonly available operational amplifiers [8]. However, in all cases, there is a need for additional circuitry that does not guarantee the generation of robust chaos. In this research, we propose to utilize the properties of switching power converters, already present in most electronic equipment, to operate in chaotic modes. The main goal is to apply the Method of Complete Bifurcation Groups to the buck converter model to identify the regions of robust chaotic oscillations where no stable periodic orbits occur. This would allow the utilization of SPC as embedded sources of chaotic signals in a wide range of applications.

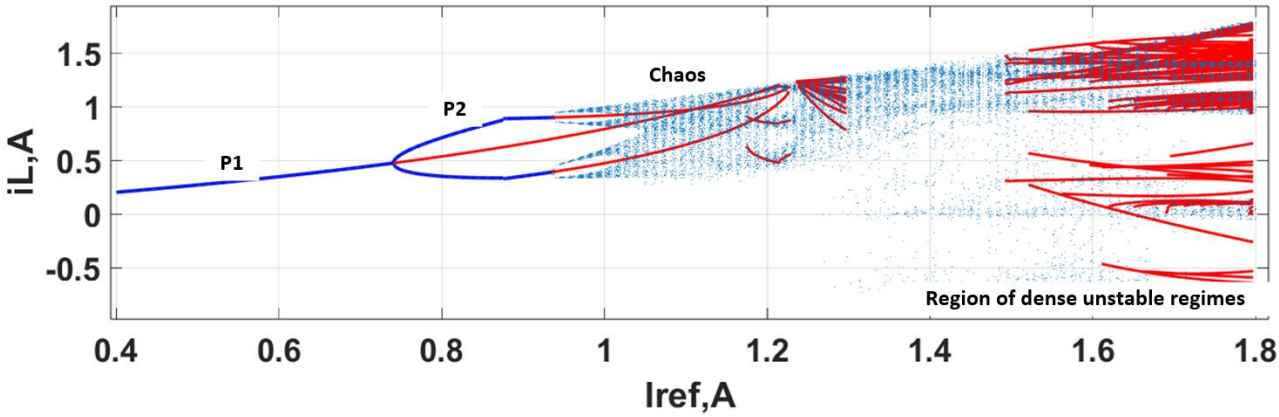

Figure 1: The complete bifurcation diagram of the buck converter under current mode control.

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