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Continuous determination of inductance current in fractional order Buck-Boost converterand

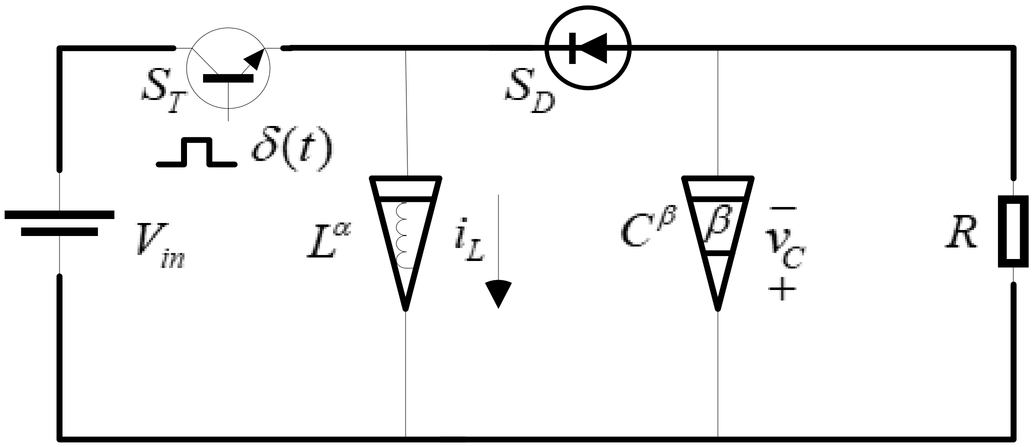
Qin Rui[1], Su Zhi Peng[2]
[1](Guang Xi University,College of Electrical Engineering, China)

Abstract: In order to solve the adaptability problem of several fractional order calculus definitions in fractional order DC-DC converter and the continuous current mode of inductor current, In this paper, a buck boost steady-state characteristic analysis method in CCM is proposed, and the judging conditions of the converter operating in CCM are given. Compared with the parameter judgment condition of the converter operating in CCM defined by Caputo, the method proposed in this paper is more accurate.
Keywords: fractional order, Buck-Boost converter, harmonic balance, steady state analysis

I. INTRODUCTION

Because inductance and capacitance are fractional order in nature, it is more accurate to model and analyze DC-DC converter by fractional calculus theory than by integer order. In reference [2], fractional calculus was used to analyze CCM The results show that there is a great difference between the fractional order model and the integer order model of boost converter based on fractional order calculus theory, and the accuracy of the model will be reduced.The criterion of the converter operating in CCM is given. the simulation model of the converter is built in Simulink, and the correctness of the theoretical analysis is verified by simulation.

II. MATHEMATICAL MODEL OF FRACTIONAL ORDER BUCK BOOST CONVERTER WITH CCM



The circuit diagram of fractional order buck boost converter is shown in Figure 1. In the diagram, V_{in} is the supply voltage, Vin=25V,δ(T) is the switching function, S_T and S_D are the switch tubes, R is the circuit resistance, R=80Ω,*L*=5mH,*C*=0.1mF/(second)$^{1-\beta}$,I_L and V_C are the inductance current and capacitor voltage of the converter respectively, and α and β are the order of the inductance and capacitance respectively.

The relationship between fractional order inductance current and capacitor voltage is as follows [11]:

$$\begin{cases} v_L(t) = L\dfrac{d^{\alpha} i_L}{dt^{\alpha}} \\ i_C(t) = C\dfrac{d^{\beta} v_C}{dt^{\beta}} \end{cases} \tag{1}$$

When α and β are equal to 1, equation (1) is an expression of integer order.

III. CCM CRITERION FOR FRACTIONAL ORDER BUCK BOOST CONVERTER

The premise of the converter in CCM is that the average inductance current of the converter is greater than its ripple [4]. When the fractional order buck boost converter satisfies the following criteria, the converter operates in CCM.

$$\frac{L}{RT^{\alpha}} > \frac{D^{\alpha}(1-D)^{2}}{2\alpha L\Gamma(\alpha)} \qquad (2)$$

D is the duty cycle of the converter, D = 0.6

The expression of inductance current ripple of fractional order buck boost converter is given by reference [5]

$$\Delta i_L = \frac{V_{in}(DT_s)^{\alpha}}{2\alpha L\Gamma(\alpha)} \qquad (3)$$

It can be seen that the DC value $I_{00} + I_{20}$ is the DC value of the converter[5], that is, the average value of the inductance current. Under the condition that the modified termination criterion is satisfied, a new method for judging the operating mode of the converter can be obtained[5].

$$N = I_{00} + I_{20} - \frac{V_{in}(DT_s)^{\alpha}}{2\alpha L\Gamma(\alpha)} \qquad (4)$$

When *N*> 0, the converter operates in CCM; when *N*< 0, the converter operates in DCM. When *N*= 0, the converter operates in CCM and intermittent critical mode.

According to equation (44), when CCM fractional order buck boost converter works stably, the region of inductance and capacitance order is shown in Fig. 2. In the figure, the green region is obtained according to the discriminant given in reference [4] that the converter is in CCM, and the green and red regions are obtained based on the discriminant of ESPM.

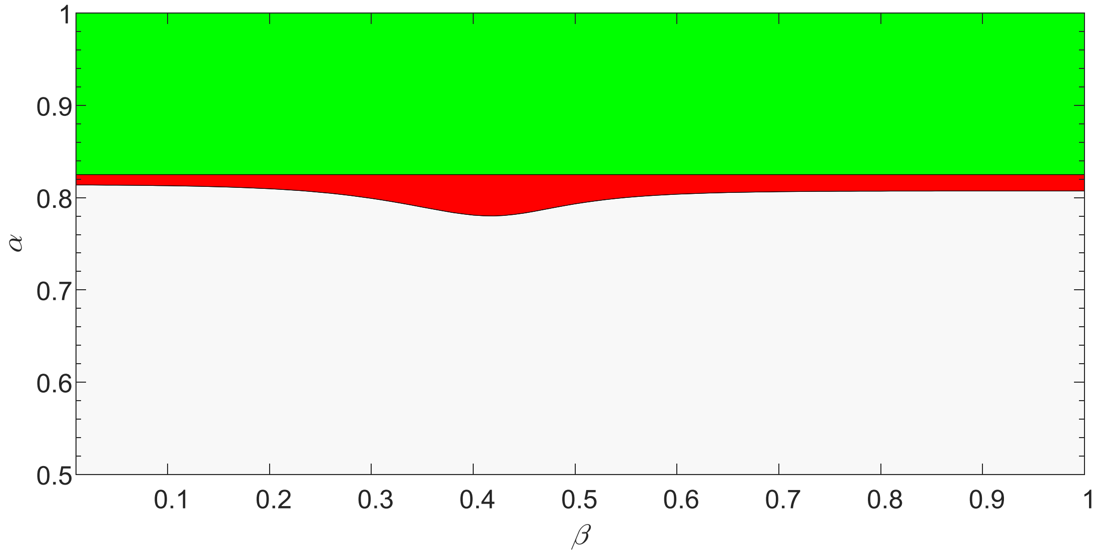


Fig.2 Region of order of inductance and capacitance of fractional CCM Buck-Boost converter in stable operation.

It can be seen from Fig. 2 that the stable operation of the converter mainly depends on the order of the inductance, and the order of the capacitor also has a certain influence on the working mode. The judgment condition in reference [6] ignores the influence of the capacitor order on the working mode.

IV. CONCLUSION

The operation of inductance current in continuous mode mainly depends on the order of inductance α, but also has some relationship with the order β of capacitance. The new method proposed in this paper is more accurate than the method defined by Caputo. The correctness of the theoretical analysis is verified by simulation.

V. ACKNOWLEDGEMENTS

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REFERENCES

[1]. WESTERLUND S. Dead matter has memory[J]. Physica Scripta, 1991, 43(2):174-179.
[2]. Fa QiangF, XiKui, Modeling and analysis of boost converter based on fractional calculus in intermittent mode,Chinese Science: Technical Science,2013,043(004): 368-374.
[3]. TRZASKA Z. Fractional-order harmonic oscillators[J]. Microwave & Optical Technology Letters, 2012, 21(3):201–205.
[4]. ERICKSON R W, MAKSIMOXIC D, Fundamentals of power electronics[M]. New York: Springer-Verlag, 2001.
[5]. CHEN X,CHEN Y F.A modeling and analysis method for fractional-order DC–DC converters, IEEE Transactions on Power Electronics,2017,32(9): 7034-7044.
[6]. YANG N N, LIU C X, WU C J. Modeling and dynamics analysis of the fractional-order Buck-Boost converter in continuous conduction mode[J]. Chinese Physics B,2012,21(8):251-261.