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A smooth version of the buck dc-dc converter

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ABSTRACT

We study, from a dynamical systems point of view, a model of a dc-dc PWM voltage-controlled buck converter working in continuous conduction mode. This model has been tested with numerical simulations, producing very similar waveforms to those in the laboratory experiments [1]. In the range of the parameters we use, continuous conduction mode is obtained, and thus the dynamic system is described by two linear topologies which commute through a discontinuous switching control action.

Some standard packages, such as AUTO [2], enable us to compute bifurcations of fixed points and periodic orbits, and continuation with regard to one or more parameters. One of the drawbacks to the modeling of the buck converter by a piecewise-linear vector field is the lack of smoothness at the switching instants. To compute periodic orbits and to do continuation, AUTO assumes that the vector field is everywhere smooth; this condition is clearly not verified in the modeling of the buck. In spite of this, some smoothing techniques will be pointed out for converting the buck system into a smooth one, ready for AUTO to be applied. In addition, one of the requirements for computing with this package is to have an autonomous system. An additional oscillator must be added to the equations in order to compute efficiently. Moreover, the experimental ramp function which defines the switching control action must be smoothed in a suitable way.

References

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[2] E.J. Doedel and X.J. Wang. AUTO94: Software for continuation and bifurcation problems in ordinary differential equations. Technical Report CRPC-95-2, California Institute of Technology, Pasadena 1995.

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